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1	Additional experiments added to AOA(1) Correct typographical errors Address non-normality issue Add results for PC platform (SCALE 4.4a) Correct USLSTATS input to include experimental uncertainties Provide justification for administrative margin
2	Address non-normality issue by performing non parametric analysis of AOA(1) data. Affected pages: 18-19, 31, 33, 46. Editorial and typographical corrections: various pages.

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LIST OF ACRONYMS

ANS	American Nuclear Society
ANSI	American National Standards Institute
AOA	area of applicability
CFR	Code of Federal Regulations
DCS	Duke Cogema Stone & Webster
DOE	U.S. Department of Energy
EALF	energy of average lethargy causing fission
FA	fuel assembly
LTB	lower tolerance band
MFFF	Mixed Oxide Fuel Fabrication Facility
MOX	mixed oxide
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
RSICC	Radiation Safety Information Computational Center
USL	upper safety limit

EXECUTIVE SUMMARY

This report documents the validation of the nuclear criticality safety codes to be used in the design of the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF), to be owned by the U.S. Department of Energy (DOE) and operated by the licensee, Duke Cogema Stone & Webster (DCS). This report is applicable to the validation of the SCALE 4.4 and SCALE 4.4a code packages [1] using the CSAS26 (KENOVI) sequence and the 238 energy group cross section library 238GROUPNDF5.

Title 10 Code of Federal Regulations (CFR) §70.61(d) requires that all nuclear processes remain subcritical under all normal and credible abnormal conditions. In order to establish that a system or process will be subcritical under all normal and credible abnormal conditions, it is necessary to establish acceptable subcritical limits for the operation and then show that the proposed operation will not exceed those values. In order to comply with this requirement, the *American National Standard for Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors ANSI/ANS–8.1–1998* [2] and the U.S. Nuclear Regulatory Commission (NRC) *Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility* [3], require that a validation be performed that (1) demonstrates the adequacy of the margin of subcriticality for safety by assuring that the margin is large compared to the uncertainty in the calculated value of k_{eff} and (2) determines the area(s) of applicability (AOA) and use of the code within the AOA, including justification for extending the AOA by using trends in the bias.

A number of design AOAs are established to cover the range of processes and fissile materials in the MFFF. AOAs covering Pu and MOX applications are as follows: (1) Pu-nitrate aqueous solutions (homogeneous systems), (2) MOX pellets, fuel rods, and fuel assemblies (heterogeneous systems), (3) PuO_2 powders, (4) MOX powders, and (5) aqueous solutions of Pu compounds (e.g., Pu-oxalate solutions). The present report addresses only the first two areas of applicability: (1) Pu-nitrate aqueous solutions and (2) MOX pellets, fuel rod, and fuel assemblies. The AOA(3) and AOA(4) areas are validated in the Part II report [16]. AOA(5) is addressed in the Part III [17].

The report concludes that the upper safety limit (USL) for the first design area of applicability (i.e., Pu-nitrate solutions) is 0.9370, and the USL for the second design area of applicability (i.e., MOX pellets, rods, and fuel assemblies) is 0.9321. The USL accounts for computational bias, uncertainties, and a 0.05 administrative margin. The final USL in each case is the more conservative of the USLs calculated separately for SCALE versions 4.4 and 4.4a.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this report is to validate the criticality codes and determine the upper safety limit (USL) to be used for performing nuclear criticality safety calculations and analyses of the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF), to be owned by the U.S. Department of Energy (DOE) and operated by the licensee, Duke Cogema Stone & Webster (DCS).

1.2 SCOPE

The scope of this report is limited to the validation of the KENO VI module and CSAS26 driver in the SCALE 4.4 and SCALE 4.4a code packages [1] for use with the 238 energy group cross-section library 238GROUPNDF5 for nuclear criticality safety calculations of the MFFF.

1.3 APPLICABILITY

The following areas of applicability (AOAs) are identified to cover a range of processes and fissile materials in the MFFF:

- Pu-nitrate aqueous solutions (homogeneous systems)
- MOX pellets, fuel rods, and fuel assemblies (heterogeneous systems)
- PuO_2 powders
- MOX powders
- Aqueous solutions of Pu compounds (e.g., Pu-oxalate solutions).

This report addresses the first two AOAs:

- Pu-nitrate aqueous solutions (homogeneous systems),
- MOX pellets, fuel rods, and fuel assemblies (heterogeneous systems).

1.4 BACKGROUND

1.4.1 Overall MFFF Design

The MFFF is designed to produce MOX fuel assemblies on an industrial scale from a mixture of depleted uranium and plutonium oxides for use in mission light-water reactors. The MFFF will be constructed on a DOE site and will be licensed by the U.S. Nuclear Regulatory Commission (NRC) under Title 10 Code of Federal Regulations (CFR) Part 70. The facility is designed to applicable U.S. codes and standards and operated by DCS, a private consortium under contract to DOE. The goal of the contract is to design, construct, and operate a facility to fabricate MOX fuel based on existing technology from the COGEMA MELOX and La Hague plants in France. To maximize the benefit of the existing technology, process and equipment designs from the MELOX and La Hague plants are duplicated, to the maximum extent possible, in the design of the new plant.

The feed material is depleted uranium dioxide and surplus plutonium dioxide (from the Pit Disassembly and Conversion Facility) supplied by DOE. The impurities in the plutonium dioxide feed are extracted by the Aqueous Polishing process. The MOX fuel fabrication process blends this "polished" plutonium dioxide with depleted uranium dioxide to form mixed oxide pellets. These pellets are loaded into fuel rods, which are integrated into fuel assemblies. The nuclear fuel assemblies are transported for use in specific U.S. commercial reactors as nuclear fuel. The MFFF is designed to process 3.5 metric tons annually, for a total disposition of 33 metric tons of plutonium (as dioxide).

1.4.2 Regulatory Requirements, Guidance, and Industrial Standards

Title 10 CFR §70.61(d) requires that "*under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety.*" In order to comply with this requirement, NUREG 1718 [3] and ANSI/ANS-8.1 [2] require a validation report that (1) demonstrates the adequacy of the margin of subcriticality for safety by assuring that the margin is large compared to the uncertainty in the calculated value of keff and (2) determines the AOAs and use of the code within the AOA, including justification for extending the AOA by using trends in the bias.

NUREG 1718 [3] further states that the validation report should contain:

> A description of the AOA that identifies the range of values for which valid results have been obtained for the parameters used in the methodology. As defined in ANSI/ANS 8.1–1983, the AOA is the range of material compositions and geometric arrangements within which the bias of a calculational method is established. Other variables that may affect the neutronic behavior of the calculational method should also be specified in the definition of the AOA. Particular attention should be given to validating the code for calculations involving mixed oxides of differing isotopics and defining the isotopic ranges covered by the available benchmark experiments. In accordance with the provisions in ANSI/ANS 8.1–1983 (applicable section is Section 4.3.2), any extrapolation of the AOA beyond the physical range of the data should be supported by an established mathematical methodology.

2. CALCULATIONAL METHOD

The SCALE 4.4 and SCALE 4.4a code packages [1] are the computational systems used for MFFF criticality analyses. The two code packages are available from the Radiation Safety Information Computational Center (RSICC). The SCALE 4.4 code package is installed and verified on the SGN Sun hardware platform [4], and the SCALE 4.4a code package is installed and verified on the SGN PC hardware platform [5].

SCALE 4.4 and SCALE 4.4a are a collection of modules designed to perform nuclear criticality, shielding, and thermal calculations. Each SCALE functional module may be run individually, or a sequence of functional modules may be executed using a special module referred to as a control module. For criticality analyses, various criticality safety analysis sequence (CSAS) control modules are available which differ in the specific functional modules executed and in the processing of cross sections used as input. In general, MFFF criticality analyses are performed using the CSAS26 control module and the 238 energy group cross-section library 238GROUPNDF5, based on ENDF/B-V data. These modules perform cross section processing using the BONAMI and NITAWL-II functional modules, and the calculation of k_{eff} is performed using the KENO VI Monte Carlo transport code.

3. CRITICALITY CODE VALIDATION METHODOLOGY

In order to establish that a system or process will be subcritical under all normal and credible abnormal conditions, it is necessary to establish acceptable subcritical limits for the operation and then show that the proposed operation will not exceed those values.

Figure 3–1 shows how the validation process fits within the overall MFFF nuclear criticality analysis process. The first step involves the procurement, installation, and verification of the criticality software on a specific computer platform. For the MFFF, the SCALE 4.4 and SCALE 4.4a code packages were procured, installed, and verified on the SGN Sun [4] and PC [5] hardware platforms, respectively. This step is followed by the validation of the criticality software, which is the purpose of this report. The final step involves the criticality safety design analysis calculations, which are performed and presented in separate reports.

The criticality code validation methodology can be divided into four steps:

- Identify general MFFF design applications
- Select applicable benchmark experiments and group them into AOAs
- Model and calculate k_{eff} values of selected critical benchmark experiments
- Perform statistical analysis of results to determine computational bias and upper safety limit (USL).

The first step is to identify the MFFF design applications and key parameters associated with the normal and upset design conditions. Table 3-2 lists some of the key parameters for the MFFF.

The second step involves several substeps. First, based on the key parameters, the AOA and expected range of the key parameter are identified. ANSI/ANS-8.1 [2] defines the AOA as "*the limiting range of material composition, geometric arrangements, neutron energy spectra, and other relevant parameters (such as heterogeneity, leakage interaction, absorption, etc.) within which the bias of a computational method is established.*" AOAs covering Pu and MOX applications are as follows: (1) Pu-nitrate solutions; (2) MOX pellets, fuel rods, and fuel assemblies; (3) PuO_2 powders; (4) MOX powders; and (5) aqueous solutions of Pu compounds. These AOAs are defined and presented in Section 4. After identifying the AOAs, a set of critical benchmark experiments is selected. Benchmark experiments for the AOAs are selected from the references listed in the *International Handbook of Evaluated Criticality Safety Benchmark Experiments [6]*, the *Guide to Verification and Validation of the SCALE-4 Criticality Safety Software [7]*, and the *Neutronics Benchmarks for the Utilization of Mixed-Oxide Fuel [8]*. A description of all relevant experiments used for each AOA considered here is provided in Section 5.

The third step involves modeling the critical experiments and calculating the k_{eff} values of the selected critical benchmark experiments[1]. Attachments 1 and 2 present calculated results.

[1] Note that these models contain simplifications of critical experiments geometry. These simplifications lead to additional uncertainties, included in the statistical analysis of the results.

The final step involves the statistical analysis of the results in order to calculate the computational bias and USL. Section 6 presents the computational bias and USL results.

3.1 DETERMINATION OF BIAS

ANSI/ANS–8.1–1998 [2] requires a determination of the calculational bias by "*correlating the results of critical and exponential experiments with results obtained for these same systems by the calculational method being validated.*" The correlation must be sufficient to determine if major changes in the bias can occur over the range of variables in the operation being analyzed. The standard permits the use of trends in the bias to justify extension of the area of applicability of the method outside the range of experimental conditions.

Calculational bias is the systematic difference between experimental data and calculated results. The simplest technique is to find the difference between the average value of the calculated results of critical benchmark experiments and 1.0. This technique gives a constant bias over a defined range of applicability.

Another technique is to find the difference between a regression fit of the calculated results of critical benchmark experiments and 1.0, as a function of an independent variable (e.g., enrichment, moderator-to-fuel ratio, etc.). As a rule, the bias is not a constant, but is dependent upon an independent variable, usually the degree of moderation of the neutrons. For example, the bias for an unmoderated system in which fission occurs with fast neutrons would not be expected to be the same as for a moderated system in which fission occurs with thermal neutrons. The AOA for the bias is the limiting range of material composition, geometric arrangement, etc., over which the bias is collectively established.

The recommended approach for establishing subcriticality based on numerical calculations of the neutron multiplication factor is prescribed in Section 5.1 of ANSI/ANS-8.17 [9]. The criteria to establish subcriticality requires that for a design application (system) to be considered as subcritical, the calculated multiplication factor for the system, k_s, must be less than or equal to an established maximum allowed multiplication factor based on benchmark calculations and uncertainty terms that is:

$$k_s \leq k_c - \Delta k_s - \Delta k_c - \Delta k_m \qquad \text{(Eq. 3.1)}$$

where:

- k_s = the calculated allowable maximum multiplication factor, (k_{eff}) of the design application (system)
- k_c = the mean k_{eff} value resulting from the calculation of benchmark critical experiments using a specific calculation method and data
- Δk_s = the uncertainty in the value of k_s
- Δk_c = the uncertainty in the value of k_c
- Δk_m = the administrative margin to ensure subcriticality.

Sources of uncertainty that determine Δk_s include:

- statistical and/or convergence uncertainties
- material and fabrication tolerances

- limitations in the geometric and/or material representations used.

Sources of uncertainty that determine Δk_c include:

- uncertainties in critical experiments
- statistical and/or convergence uncertainties in the computation
- extrapolation outside of the range of experimental data
- limitations in the geometric and/or material representations used.

An assurance of subcriticality requires the determination of an acceptable margin based on known biases and uncertainties. The USL is defined as the upper bound for an acceptable calculation.

Critical benchmark experiments used to determine calculational bias (β) should be similar in composition, configuration, and nuclear characteristics to the system under examination. The range of applicability may be extended beyond the range of conditions represented by the benchmark experiments by extrapolating the trends established for the bias. β is related to k_c as follows:

$$\beta = k_c - 1 \qquad \text{(Eq. 3.2)}$$

$$\Delta\beta = \Delta k_c \qquad \text{(Eq. 3.3)}$$

Using this definition of bias, the condition for subcriticality in Eq. 3.1 is rewritten as:

$$k_s + \Delta k_s \leq 1 - \Delta k_m + \beta - \Delta\beta \qquad \text{(Eq. 3.4)}$$

A system is acceptably subcritical if a calculated k_{eff} plus calculational uncertainties lies at or below the USL.

$$k_s + \Delta k_s \leq \text{USL} \qquad \text{(Eq. 3.5)}$$

The USL can be written as:

$$\text{USL} = 1 - \Delta k_m + \beta - \Delta\beta \qquad \text{(Eq. 3.6)}$$

Bias is negative if $k_c < 1$ and positive if $k_c > 1$. For conservatism, a positive bias is set equal to zero for the purpose of defining the USL. $\Delta\beta$ is typically determined at the 95% confidence level.

The USL takes into account bias, uncertainties, and administrative and/or statistical margins such that the calculated configuration will be subcritical with a high degree of confidence.

β is related to system parameters and may not be constant over the range of a parameter of interest. If k_{eff} values for benchmark experiments vary as a function of a system parameter, such as enrichment or degree of moderation, then β can be determined from a best fit as a function of the parameter upon which it is dependent. Extrapolation outside the range of validation must take into account trends in the bias.

Both $\Delta\beta$ and β can vary with a given parameter, and the USL is typically expressed as a function of the parameter. Normally, the most important system parameter that affects bias is the degree

of moderation of the neutrons. This parameter can be expressed in several different ways, such as the energy of average lethargy causing fission (EALF), moderator-to-fuel volume ratio (v^m/v^f), or moderator-to-fuel atomic ratio (H/Pu ratio).

In general, the "bias" can be broken down into components caused by system modeling error, code modeling inaccuracies, cross-sectional inaccuracies, etc. Biases associated with individual inaccuracies are usually combined into a total bias to represent the combined effect from all sources that prevent code and cross-sections from calculating the experimental value of k_{eff} (see Section 0).

One or two calculations are insufficient to determine calculational bias. In practice, it is necessary to determine the "average bias" for a group of experiments. A statistical analysis of the variation of biases around this average value is used to establish an uncertainty associated with the bias value when it is applied to a future calculation of a similar critical system. The lower limit of this band of uncertainty establishes an upper bound for which a future calculation of k_{eff} for a similar critical system can be considered subcritical with a high degree of confidence.

NUREG/CR-6361 [10] describes two statistical methods for the determination of an USL from the bias and uncertainty terms associated with the calculation of criticality. The first method applies a statistical calculation of the bias and its uncertainty, plus an administrative margin, to a linear fit of critical experimental benchmark data. The second method applies a statistical calculation to determine a combined lower confidence band and subcritical margin. Both methods assume that the distribution of data points is normal. The following discussion of each method is taken from NUREG/CR-6361 [10] and is based on equations and techniques described in Dryer, Jordan, and Cain [11], Easter[12], Bowden and Graybill [13], Johnson [14], and Cain [15].

3.2 USL METHOD 1: CONFIDENCE BAND WITH ADMINISTRATIVE MARGIN

This method applies a statistical calculation of the bias (β) and its uncertainty ($\Delta\beta$) plus an administrative safety margin (Δk_m) to a linear fit of calculated results for a selected set of critical experiments. A confidence band (W) is determined statistically based on the existing data and a specified level of confidence; the greater the standard deviation in the data or the larger the confidence desired, the larger the band width will be. This confidence band, W, accounts for uncertainties in the experiments, the calculational approach, and calculational data (e.g., cross sections) and is therefore a statistical basis for $\Delta\beta$, the uncertainty in the value of β. W is defined for a confidence level of ($1-\gamma_1$) using the relationship:

$$W = \max\{w(x)|_{x\,min,\,x\,max}\} \qquad \text{(Eq. 3.7)}$$

where

$$w(x) = t_{1-\gamma_1} s_p \left[1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{\sum_{i=1,n}(x_i-\bar{x})^2} \right]^{\frac{1}{2}} \qquad \text{(Eq. 3.8)}$$

and

n = the number of critical calculations used in establishing $k_c(x)$

$t_{1-\gamma_1}$ = the Student - t distribution for $1-\gamma_1$ and n - 2 degrees of freedom

$\bar{x}$ = the mean value of parameter x in the set of calculations

s_p = the pooled standard deviation for the set of criticality calculations.

The function w(x) is a curvilinear function. For simplicity, it is desirable to obtain a constant width margin. Therefore, for conservatism, the confidence band, W, is defined as the maximum of $(w(x_{min}), w(x_{max}))$, where x_{min} and x_{max} are the minimum and maximum values of the independent parameter x, respectively. Typically, W is determined at a 95% confidence level.

The pooled standard deviation is obtained from the pooled variance $S_p = \sqrt{S_p^2}$, where S_p is given as:

$$S_p^2 = S_{k(x)}^2 + S_w^2 \qquad \text{(Eq. 3.9)}$$

Where $S_{k(x)}^2$ is the variance (or mean square error) of the regression fit, and is given by:

$$s_{k(x)}^2 = \frac{1}{(n-2)}\left[\sum_{i=1,n}(k_i-\bar{k})^2 - \frac{\left\{\sum_{i=1,n}(x_i-\bar{x})(k_i-\bar{k})\right\}^2}{\sum_{i=1,n}(x_i-\bar{x})^2}\right] \qquad \text{(Eq. 3.10)}$$

and S_w^2 is the within-variance of the data:

$$s_w^2 = \frac{1}{n}\sum_{i=1,n}\sigma_i^2 \qquad \text{(Eq. 3.11)}$$

where σ_i is the standard deviation associated with k_i for a Monte Carlo calculation. It is recommended that the individual standard deviations for Monte Carlo calculations be roughly uniform in value for the best results. For deterministic codes that do not have a standard deviation associated with a computed value of k, the standard deviation is zero. However, this term can also be used as a mechanism to include known uncertainties in experimental data.

In USL Method 1, Δk_m is given an arbitrary administrative value. NUREG-1718 [3] states that a "minimum subcritical margin (Δk_m) of 0.05 is generally considered acceptable without additional justification when both the bias and its uncertainty are determined to be negligible." The MFFF criticality analyses use a value of 0.05. Section 7.1 provides further justification of the 0.05 administrative margin.

Having determined the constant W and substituting for $\Delta\beta$ in equation 3.6, the expression for the USL may be written as:

$$USL_1(x) = 1.0 - \Delta k_m - W + \beta(x). \qquad \text{(Eq. 3.12)}$$

3.3 USL METHOD 2: SINGLE-SIDED UNIFORM WIDTH CLOSED INTERVAL APPROACH

In USL Method 2, sometimes referred to as a lower tolerance band (LTB) approach, statistical techniques are applied to determine a combined lower confidence band plus subcritical margin. In USL Method 1, Δk_m and $\Delta\beta$ are determined independently, and in USL Method 2 (LTB method), a combined statistical lower bound is determined.

The purpose of this method is to determine a uniform tolerance band over a specified closed interval for a linear least-squares model. The level of confidence in the limit being calculated is α and is typically in the range of 0.90 to 0.999.

The USL Method 2 is defined as:

$$USL_2(x) = 1.0 - (C_{\alpha/P} \cdot s_p) + \beta(x) \qquad \text{(Eq. 3.13)}$$

where s_p is the pooled variance of k_c described earlier. The term $C_{\alpha/P} \cdot s_p$ provides a band for which there is a probability P with a confidence α that an additional calculation of k_{eff} for a critical system will lie within the band. For example, a $C_{95/99.5}$ multiplier produces a USL for which there is a 95% confidence that 995 out of 1000 future calculations of critical systems will yield a value of keff above the USL.

The analysis is over the closed interval from $x = a$ to $x = b$. $C_{\alpha/P}$ is calculated according to the following equations:

$$g = \sqrt{\frac{1}{n} + \frac{(a-\bar{x})^2}{\sum_{i=1}^{n}(x_i-\bar{x})^2}} \qquad \text{(Eq. 3.14)}$$

$$h = \sqrt{\frac{1}{n} + \frac{(b-\bar{x})^2}{\sum_{i=1}^{n}(x_i-\bar{x})^2}} \qquad \text{(Eq. 3.15)}$$

$$\rho = \frac{1}{gh} \cdot \left\{ \frac{1}{n} + \frac{(a-\bar{x})(b-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2} \right\} \qquad \text{(Eq. 3.16)}$$

$$A = \frac{g}{h} \qquad \text{(Eq. 3.17)}$$

A, ρ, and $(n\text{-}2)$ are used to determine the value of D from Table 3 in Bowden [13], which covers values of $0.5 \leq A \leq 1.5$. The procedure to follow when A is in this range is:

$$C^* = D \cdot g. \qquad \text{(Eq. 3.18)}$$

When A is outside the above range, A is replaced by $1/A$ for the determination of D, and C^* is given by:

$$C^* = D \cdot h. \qquad \text{(Eq. 3.19)}$$

Next,

$$C_{\alpha/P} = C^* + z_p \cdot \sqrt{\frac{n-2}{\chi^2}}, \qquad \text{(Eq. 3.20)}$$

where

z_p = the Student t statistic depending on n and P
χ^2 = the chi square distribution, a function of $n\text{-}2$ and α.

This approach provides a statistically based subcritical margin, Δk_m which can be determined as the difference $(C_{\alpha/P} \cdot s_p)$-W. In criticality safety applications, such a statistically determined approach generally, but not necessarily, yields a margin of less than 0.05, which serves to illustrate the adequacy of the administrative margin specified in USL Method 1. The recommended purpose of USL Method 2 is to apply it in tandem with USL Method 1 to verify that the administrative margin is conservative relative to a purely statistical basis.

3.4 NON-NORMAL DISTRIBUTIONS

In cases where the benchmark results fail the χ^2 test for normality, the non-parametric technique described in NUREG-6698 [18] is applied to the data. This statistical technique is based on a rank order analysis of the data. The USL is established according to

USL = Smallest k_{eff} value – Uncertainty for smallest k_{eff} – Nonparametric margin – Δk_m (Eq. 3.21)

Where the non-parametric margin is an additional margin intended to account for small sample size. Recommended values for the non-parametric margin as a function of the degree of confidence are obtained from Table 2.2 of NUREG-6698, which is reproduced in Table 3-1.

The degree of confidence β that a fraction q of the population is greater than the lowest observed value is established for a given sample size n according to

$$\beta = 1 - q^n \qquad \text{(Eq. 3.22)}$$

For a desired population fraction of 95%, this becomes

$$\beta = 1 - 0.95^n \qquad \text{(Eq. 3.23)}$$

In order to obtain a 95% confidence that 95% of the population is larger than the smallest observed sample, at least 59 critical experiments are required.

Table 3-1 Recommended Non-Parametric Margin Values from NUREG-6698

Degree of Confidence for 95% of the Population	Non-parametric Margin (NPM)
>90%	0.00
>80%	0.01
>70%	0.02
>60%	0.03
>50%	0.04
>40%	0.05
≤40%	Additional data needed. (This corresponds to less than 10 data points.)

3.5 UNCERTAINTIES

Uncertainties, as used in this report, refer to the uncertainty in k_{eff} associated with experimental unknowns or assumptions and to the uncertainty values associated with Monte Carlo analyses.

Experimental uncertainty (σ_e) – Modeling of validation experiments frequently result in assumptions about experimental conditions. In addition, experimental uncertainties (such as measurement tolerances) influence the development of a computer model. Recent efforts by the OECD – NEA [6] have resulted in the quantification of these uncertainties in validation experiments.

Statistical uncertainty (σ_s) – Monte Carlo calculation techniques result in a statistical uncertainty associated with the actual calculation. This type of uncertainty is dependent upon many factors, including number of neutron generations performed, variance reduction techniques employed, and problem geometry. For this document, σ_s refers to the statistical Monte Carlo uncertainty associated with the computer modeled validation experiment.

Total uncertainty –This is the total uncertainty associated with a calculated k_{eff} on a benchmark experiment. The total uncertainty for an individual benchmark is the combined error of the experimental and statistical uncertainties:

$$\sigma_t = \sqrt{\sigma_{e,t}^2 + \sigma_{s,t}^2} \qquad \text{(Eq. 3.24)}$$

where the subscript (i) refers to an individual benchmark calculation.

3.6 NORMALIZING K_{EFF}

In many instances, benchmark experiments used for validation may not be exactly critical. Experimental results may show that the experiment is slightly above or below a $k_{eff} = 1.0$. For

these cases, the calculated k_{eff} values should be normalized to the experimental value. This assumes that any inherent bias in the calculation is not affected by the normalization, which is valid for small differences in k_{eff}. To normalize k_{eff}, the following formula applies:

$$k_{eff}\text{ (normalized)} = k_{eff}\text{ (calculated)} / k_{eff}\text{ (experimental)} \qquad \text{(Eq. 3.25)}$$

The normalized k_{eff} values are to be used in the determination of the USL. Since only small adjustments to the calculated k_{eff} value are made as a result of normalization, no adjustment to the total uncertainty, σ_t, is made.

3.7 APPLICATION OF THE USL

The equations for USL Methods 1 and 2 (equations 3.12 and 3.13) represent an upper bound to assure subcriticality for a given configuration when the calculated k_{eff} plus uncertainty for the configuration is less than the USL. USLs may be calculated for a number of independent parameters for a given system. Here, the subcritical limit is taken as the minimum of all USLs computed for the specific parameters of the system. This approach is conservative with respect to the guidance provided in NUREG/CR-6361 [10] in which the USL is determined based on the statistical results for the parameter "*with the strongest correlation to the calculated k_{eff} values.*"

Another advantage of the USL is that it may also be used to establish guidelines for quantitatively determining the applicability of the bias (or validation) to specific applications. For a given parameter, the USL is valid over the range of that parameter in the set of calculations used to determine the USL. However, ANSI/ANS-8.1 [2] allows the range of applicability to be extended beyond this range by extrapolating the trends established for the bias. No precise guidelines are specified for the limits of extrapolation. Thus, engineering judgment should be applied when extrapolating beyond the range of the parameter bounds.

Appendix C in NUREG/CR-6361 [10] documents the USLSTATS computer program that was developed to perform the required statistical analysis and calculate USLs based on USL Methods 1 and 2.

In this validation report, USLSTATS is used to trend the following parameters:

- Moderator to fuel atomic ratio (H/Pu)
- Energy of Average Lethargy Causing Fission (EALF)
- Moderator to Fuel Volume Ratio (v^m/v^f)
- ^{240}Pu and PuO_2 content

The H/Pu ratio is a parameter that describes the moderation of the neutrons in the fissile medium. The moderator to fuel volume ratio, v^m/v^f, has a similar meaning for fuel rod lattices. The EALF parameter is a measure of the energy dependent fission efficiency of the fissile medium.

The administrative margin, Δk_m, is fixed in order to have a sufficient confidence that the calculated results are subcritical.

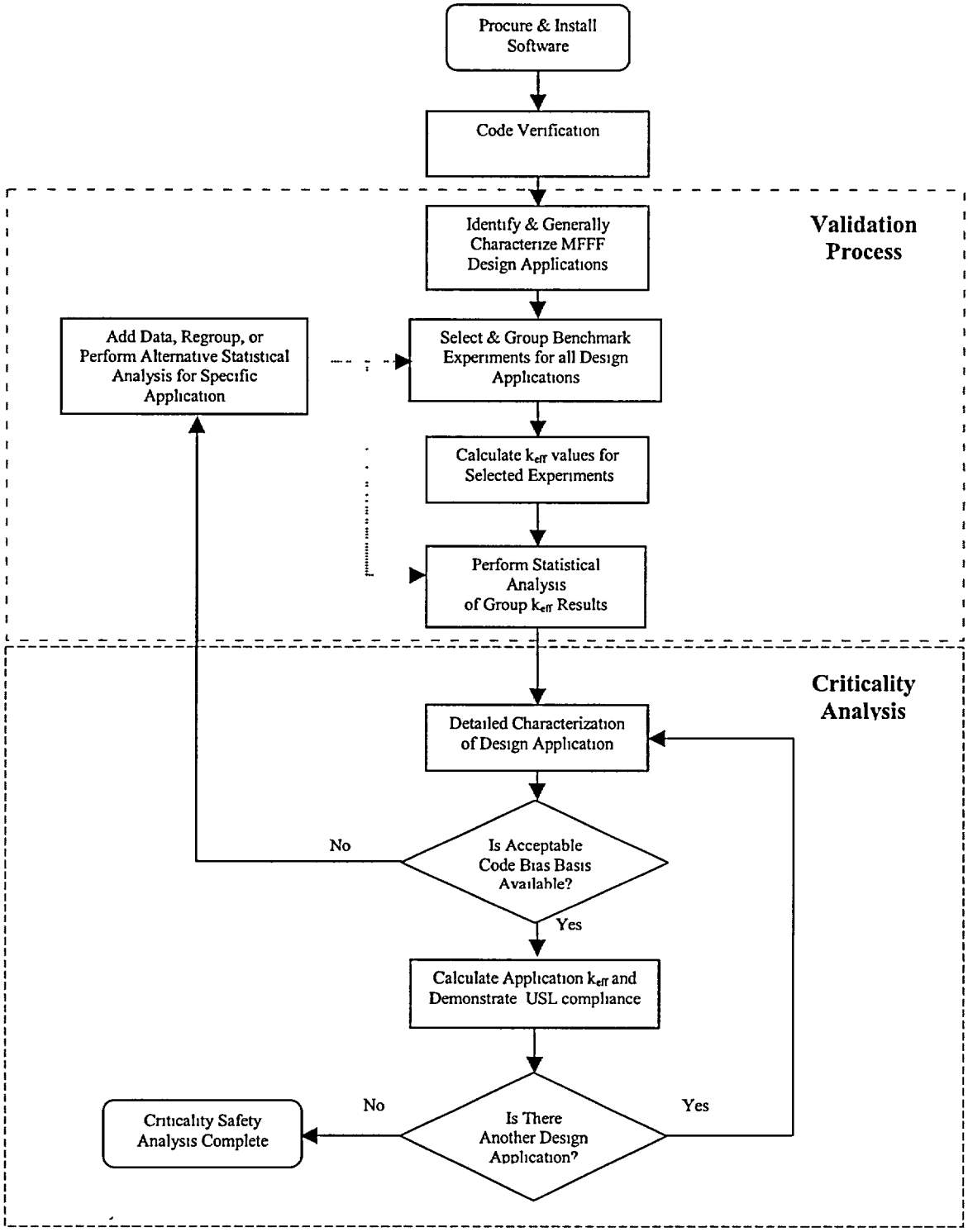

Figure 3–1 Overview of the Criticality Analysis Process of the MFFF

Table 3-2 Characteristics of the MFFF Application Areas*

Parameter	Pu-nitrate solution	MOX pellets, fuel rods, FAs	PuO_2 powder/water mixtures	MOX powder/water mixtures	Aqueous solutions of Pu compounds
Fissile Material Physical/Chemical Form	Pu-nitrate	MOX green and sintered pellets, MOX Rods and FAs	PuO_2 powder	MOX powder	(a) Pu-oxalate (b) PuO_2F_2
Isotopic composition of fissile material **	96% ^{239}Pu 4% ^{240}Pu	96% ^{239}Pu 4% ^{240}Pu depleted U	96% ^{239}Pu 4% ^{240}Pu	96% ^{239}Pu 4% ^{240}Pu depleted U	96% ^{239}Pu 4% ^{240}Pu
Pu/(U+Pu)	100 %	≤ 6.3 %	100 %	6.3% – 22%	100 %
Maximum oxide density [g/cm^3]	–	7.0, 11.0	3.5, 7.0, 11.46	4.1, 5.5	–
Pu concentration [g/liter]	125 – 237	–	–	–	(a) 242 (b) 696
Type of moderation	Homogeneous	Heterogeneous	Homogeneous	Homogeneous	Homogeneous
Optimum moderation ***	H/Pu=100–200	v^m/v^f= 1.9 – 9	H/Pu= 0.3 – 6 and 700 – 1900	H/Pu=1.6 – 291	(a) H/Pu=100 (b) H/Pu=30
Low density moderation [wt.% H_2O]	–	≤ 5 ****	≤ 5	≤ 5	–
Anticipated absorber/reflector materials	Water Cd/water Concrete Borated concrete	Water Concrete Borated concrete	Water Borated concrete	Water	Water Cd/water Concrete
Typical geometry	Annular cylinders Cylinders Slabs	Cylinders Arrays Cuboids	Various configurations	Various configurations	Annular cylinders Cylinders Slabs

* Characteristics presented typically refer to optimal or bounding values or ranges associated with respective AOAs
** Bounding design isotopic composition from Aqueous Polishing System basis of design
*** Per calculation
**** Green Pellets (i.e., unsintered pellets) < 5; sintered pellets < 1

4. MFFF DESIGN APPLICATION CLASSIFICATION

This section describes the characteristics of the established AOAs based on the various fuel configurations encountered in the MFFF. AOAs covering Pu and MOX applications are as follows (see Table 3-2):

- Pu-nitrate aqueous solution
- MOX pellets, fuel rods, and fuel assemblies (FA)
- PuO_2 powders
- MOX powders
- Aqueous solutions of Pu compounds (e.g., Pu-oxalate solution).

4.1 DESIGN APPLICATION (1) – PU-NITRATE SOLUTION

Table 4-1 summarizes the anticipated criticality calculations to be performed for the design of the Aqueous Polishing process of the MFFF in which Pu-nitrate will be processed. The table provides the relevant parameters (i.e., chemical form, isotopic vector, moderator to fuel atomic ratio (H/Pu), and EALF) for each criticality design application.

Since geometry control is expected to be used for all the equipment listed in Table 4-1, the calculations are performed at optimum moderation taking into account full water reflection. In some applications (e.g., mixer-settler tanks), the reflector is modified by cadmium/water materials and borated concrete materials.

4.2 DESIGN APPLICATION (2) – MOX PELLETS, FUEL RODS, AND FUEL ASSEMBLIES

Table 4-2 summarizes the anticipated criticality calculations to be performed for the design of the MOX process pellet, fuel rod, and fuel assembly lines. In addition, the table provides the relevant parameters (i.e., chemical form, fuel concentration C(Pu), isotopic vector, moderator to fuel volume ratio (v^m/v^f), and EALF) for each criticality design application.

In the pellet and fuel rod area, a conservative value of 6.3% Pu content is used to bound the design limit of 6.0%. The maximum assembly-averaged Pu content in the fuel assembly area is less than 6.0%. The value depends on the FA type that is specified by the MFFF customers (i.e., utility reactors) and will be incorporated into the criticality design application calculations.

Table 4-1 Anticipated Characteristics for the Design Application Involving Pu-nitrate Solutions

Fuel Configuration	Reflector Conditions	Chemical Form	Pu/ (U+Pu)	Pu Isotopic Composition	H/Pu	C(Pu) [g/l]	EALF [eV]
AP: Purification							
Mixer-settler tank	Slab with Cd/water reflector	$Pu(NO_3)_3$	100%	4% ^{240}Pu	100	237	0.20
Active gallery	Array of interacting cylinders	$Pu(NO_3)_3$	100%	4% ^{240}Pu	150	164	0.14
Pulsed columns	Cylinder with water reflector	$Pu(NO_3)_3$	100%	4% ^{240}Pu	150	194	0.14
Tanks in cell	Annular cylinder with concrete reflector Slab with Cd/water reflector	$Pu(NO_3)_3$	100%	4% ^{240}Pu	200	125	0.18
AP: Oxalic Precipitation Oxidation							
Tanks in cell	Annular cylinder with concrete reflector	$Pu(NO_3)_3$	100%	4% ^{240}Pu	200	125	0.18
Dosing wheels	Rectangular solid with steel water reflector	$Pu(NO_3)_3$	100%	4% ^{240}Pu	150	164	0.25
Expected Range of Design Application	**Various configurations**	**$Pu(NO_3)_3$**	**100%**	**4% ^{240}Pu**	**100 – 200**	**125 – 237**	**0.14 – 0.25**

Table 4-2 Anticipated Characteristics for the Design Application Involving MOX Pellets, Fuel Rods, Fuel Assemblies

Fuel Configuration	Reflector Condition	Chemical Form	Pu/(U+Pu) wt. %	Pu Isotopic Composition	v^m/v^f	EALF [eV]
MP: Pellet area						
Sintering furnace Heterogeneous Array*	Water and concrete	MOX	6.3%	4% ^{240}Pu	2 – 10	0.1 – 1
Pellets boats in the return glove box of the sintering furnace Heterogeneous Array	Water	MOX	6.3%	4% ^{240}Pu	2 – 10	0.1 – 1
Glove boxes Heterogeneous Array	Water	MOX	6.3%	4% ^{240}Pu	2 – 10	0.1 – 1
Pellets boats and boxes store Heterogeneous Array	Water, boron shield	MOX	6.3%	4% ^{240}Pu	2 – 10	0.1 – 1
Pellets stored in tray baskets Heterogeneous Array	Water, concrete boron shield	MOX	6.3%	4% ^{240}Pu	2 – 10	0.1 – 1
MP: Rod area						
Rod store Rectangular array	Water boron shield	MOX	6.3%	4% ^{240}Pu	2 – 5	0.1 – 0.5
MP: Fuel Assembly Area						
MOX FA store Rectangular array	Water and concrete	MOX	2.0%–6.3%	4% ^{240}Pu	~1.9	0.1 – 0.5
Expected Range of Design Application	**Various**	**MOX**	**2.0%–6.3%**	**4% ^{240}Pu**	**1.9 – 10**	**0.1 – 1**

* Random orientation of pellets modeled as regular arrays with hexagonal or rectangular pitch

5. BENCHMARK EXPERIMENTS

5.1 AOA (1) – PU-NITRATE SOLUTION

Fifteen benchmark experiments, consisting of a total of 191 critical configurations, with Pu-nitrate solution are selected from the ICSBEP Handbook [6] for AOA(1). One or more of the following criteria are used for selecting an experiment:

- Moderator-to-fuel atomic ratio H/Pu appropriate for the area of applicability.
- The presence of a water reflector, cadmium/water reflector, or concrete reflector.
- Neutron interaction between bare cylinders arranged in an array.
- Bare spheres without significant reflectors in order to represent the normal unreflected design application.

The identification numbers of the benchmarks selected from Reference [6] are listed below:

PU_SOL_THERM_001, 002, 003, 004, 005, 006, 008, 011, 014, 015, 016, 017, 020, 025, 026.

A description of the key parameters of these experiments is presented in Table 5-1. Table 5-2 provides a comparison of the key AOA parameters for the critical benchmark experiments and the design applications.

5.2 AOA (2) – MOX-PELLETS, FUEL RODS, FUEL ASSEMBLIES

Five benchmark experiments are selected from the ICSBEP-Handbook [6] for AOA(2). These benchmarks include 36 critical configurations performed with lattices of MOX fuel rods in water having various Pu contents and moderating ratios (v^m/v^f).

The ID numbers of the selected benchmarks are listed below :

MIX_COMP_THERM_002, 003, 004, 005, 009.

A description of the key parameters of the selected experiments is presented in Table 5-3. Table 5-4 provides a comparison of the key AOA parameters for the critical experiments and the design applications.

Table 5-1 Critical experiments selected for AOA(1)

Case ID From [6]	H/Pu	EALF [eV]	Reflector/ Geometric form	^{240}Pu wt. %	Description
PU-SOL-THERM-001	87–353	0.09–0.35	Water reflected sphere	4.67	11.5" diameter sphere
PU-SOL-THERM-002	299–508	0.07–0.10	Water reflected sphere	3.12	12" diameter sphere
PU-SOL-THERM-003	545–774	0.06–0.07	Water reflected sphere	1.76, 3.12	13" diameter sphere
PU-SOL-THERM-004	573–982	0.05–0.07	Water reflected sphere	0.54 to 3.43	14" diameter sphere
PU-SOL-THERM-005	557–866	0.06–0.07	Water reflected sphere	4.05, 4.40	14" diameter sphere
PU-SOL-THERM-006	911–1028	0.05–0 06	Water reflected sphere	3.12	15" diameter sphere
PU-SOL-THERM-008	85–867	0.06–0.55	Concrete reflected and concrete/Cd reflected sphere	4.67	14" diameter sphere
PU-SOL-THERM-011	551–1157	0.05–0.08	Bare sphere	4.2	Bare 16" and 18" diameter spheres
PU-SOL-THERM-014	210	0.17	Unreflected array of cylinders	4.23	Interacting cylinders in air (115.1gPu/l)
PU-SOL-THERM-015	155	0.24	Unreflected array of cylinders	4.23	Interacting cylinders in air (152.5gPu/l)
PU-SOL-THERM-016	155–210	0.17–0.24	Unreflected array of cylinders	4.23	Interacting cylinders in air with (152.5 gPu/l and 115.1 gPu/l)
PU-SOL-THERM-017	210	0.17	Unreflected array of cylinders	4.23	Interacting cylinders in air (115.1gPu/l)
PU-SOL-THERM-020	341–754	0 06–0.11	Water reflected, Water/Cd reflected sphere	4.67	14" diameter sphere
PU-SOL-THERM-025 Case 1 to 6	424	0.08	Water-reflected slab	4.67	Isolated slab tank in water (58 gPu/l)
PU-SOL-THERM-026 Case 1 to 3	425–430	0.09	Unreflected slab	4.67	Isolated slab tank in air (57.3 and 57.7 gPu/l)

Table 5-2 AOA (1) – Comparison of key parameters

Parameter	Design application (cf. Table 4-1)	Benchmark (cf. Table 5-1)
Geometric shape	Cylinder Slab Annular cylinder Array of cylinders	Sphere Slab Array of cylinders
Reflector conditions	Full water Cd/water Borated concrete	Full water Cd/water Concrete
Chemical form	Pu nitrate solution	Pu nitrate solution
Pu/(U+Pu)	100 wt. %	100 wt. %
Isotopic composition [wt. % ^{240}Pu]	4.00	0.54–4.67
H/Pu	100–200	85–1157
C(Pu) [g/l]	125–237	22–269
EALF [eV]	0.14–0.25*	0.05–0.55

* at the optimum of moderation

Table 5-3 Critical experiments selected for AOA(2)

Case No. [6]	v^m/v^f	EALF [eV]	Reflector/ geometric form	PuO_2 wt. %	^{240}Pu wt. %	Description
MIX-COMP-THERM-002	1.19–3.64	0.14–0.77	Water	2.04	8.0	Rectangular Lattices of Water-moderated UO_2–PuO_2 Fuel Rods
MIX-COMP-THERM-003	1.7–10.75	0.10–0.91	Water radial	6.6	8.6	Rectangular Lattices of Water-Moderated UO_2–PuO_2 Fuel Rods
MIX-COMP-THERM-004	2.4–5.6	0.08–0.15	Water radial	3.0	22	Rectangular Lattices of UO_2-PuO_2 Fuel Rods in Water
MIX-COMP-THERM-005	1.9–10.1	0.09–0.39	Water	4.0	18	Water-Moderated Mixed UO_2-PuO_2 Pins in Hexagonal Lattices
MIX-COMP-THERM-009	1.1–5.6	0.09–0.55	Water	1.5	8	Mixed Oxide Fuel Pin Hexagonal Lattice, Depleted Uranium

Table 5-4 AOA (2) – Comparison of key parameters

Parameter	Design application (cf. Table 4-2)	Benchmark (cf. Table 5-3)
Geometrical shape	Heterogeneous lattices, Rectangular lattices	Rectangular lattices Hexagonal lattices
Absorber / Reflector	Water, Concrete Borated Shield	Water –
Chemical form	Mixed oxide	Mixed oxide
$PuO_2/(UO_2+PuO_2)$ [wt. %]	2.0 – 6.3	1.5–6.6
Isotopic composition [wt. % ^{240}Pu]	4	8–22
v^m/v^f	1.9–10	1.1–10.75
EALF [eV]	0.1–1.0	0.08–0.91

6. ANALYSIS OF VALIDATION RESULTS

6.1 DESIGN APPLICATION (1) - AQUEOUS SOLUTIONS OF PU-NITRATE

One hundred ninety-one critical experiments are modeled with CSAS26/KENO VI using the 238 energy group cross sections library 238GROUPNDF5 on both the Sun and PC platform. These experiments include the following geometries:

- Bare (unreflected) spheres,
- Water reflected spheres,
- Concrete reflected spheres,
- Interacting cylinders,
- Water reflected slabs,
- Unreflected slabs,
- Cadmium/concrete reflected spheres,
- Cadmium/water reflected spheres.

The calculated k_{eff} values are presented in Attachment 1A and 1B for the Sun and PC platforms, respectively. Figure 6–1 shows the distribution of the calculated k_{eff} values for the AOA(1) design application (Pu-nitrate solutions) for SCALE 4.4 on the Sun platform and SCALE 4.4a on the PC platform. The results are analyzed statistically with the USLSTATS computer code using three trending parameters: H/Pu, EALF and ^{240}Pu content. In all cases, the calculated k_{eff} values are normalized by the handbook experimental k_{eff} values (see Section 3.5) in order to provide a consistent basis of comparison among the experiments.

Although the USLSTATS approach is the preferred statistical technique for determining the USL, the method is based on an assumption that the distribution of benchmark critical values is normal. The data analyzed here does not pass the χ^2 test for normality employed in the USLSTATS code. Hence, an additional analysis of the data is performed using the non-parametric (NPM) technique described in Section 3.4. The final USL is determined based on the more conservative of the USLs established separately using the USLSTATS approach and the NPM technique. The USLSTATS approach leads to a more conservative USL and this result is maintained as the USL for AOA(1) in order to maintain consistency with previous analysis.

The EALF parameter of the selected experiments ranges from 0.05 eV to 0.55 eV and the range of H/Pu atomic ratios goes from 85 to 1157, cf. Table 5-1.

Table 6-1 and Table 6-2 summarize the statistical results of the USLSTATS program for Sun and PC platforms, respectively. It can be noted that the range of EALF obtained with these experiments covers the EALF values of AOA(1), cf. Table 4-1. Figure 6–2 through Figure 6–4 show the results graphically. All positive biases are conservatively set to zero.

6.1.1 USL with EALF and H/Pu ratio

Figure 6–2 and Figure 6–3 show the k_{eff} values calculated on each platform and the values of USL-1 and USL-2 versus the trending parameters EALF and H/Pu, respectively. The corresponding USLSTATS output listings are presented in Attachment 3 for PC values and in Attachment 4 for Sun values.

Note that the data does not pass the normal distribution test for the full set of experiments (See the USLSTATS outputs in Attachments 3 and 4). The non-normality of the data can be observed in Figure 6–1. Evaluation of the data indicates that the non-normality is due to acceptable differences in the benchmark experiments. Consequently, all the data is used to establish the USL. By performing a graphical analysis of the data in Figure 6–2 through Figure 6–4 it is apparent that the minimum normalized k_{eff} value is bounded by a value of 0.9900. With the application of a 0.05 administrative margin, the graphical analysis of the data indicates that a USL of 0.9400 is adequate.

In addition, the results of the USLSTATS analysis of the data are shown in Table 6-1 and Table 6-2 for each trending parameter. For AOA(1), the minimum USL-1 with a 0.05 administrative margin is 0.9370(a)/0.9372(b)[2]. The USL-2 analysis indicates that a suitable minimum margin of subcriticality for this AOA is 0.029(a)/0.029(b) (See Section 3.3). This indicates that the administrative margin (Δk_m =0.05) applied to the USL-1 value is adequate for the AOA(1) application provided the EALF and H/Pu ratio fall within the applicable range.[3] Since the USL calculated with USLSTATS is less than that determined by performing a graphical analysis of the data, the USL calculated with USLSTATS is used for conservatism.

The two versions of SCALE running on different hardware platforms show no statistically significant differences in results. Taking the minimum computed USL for each platform, a USL of 0.9370 is justified for both SCALE 4.4 and SCALE4.4a for the Pu-nitrate solution area of applicability.

6.1.2 USL with ^{240}Pu content in Plutonium

Forty-six experiments were selected from PU_SOL_THERM_001, 002, 003, 004, 005 and 006 to evaluate the effect of the ^{240}Pu ratio on the calculational bias. The ^{240}Pu content in the fissile solutions of Pu-nitrate used in the experiments varied from 0.54 wt. % to 4.67 wt. %. This reduced set of experiments is selected because the experiments have otherwise very similar characteristics, therefore exposing ^{240}Pu effect to the greatest extent:

- Plutonium nitrate solution,
- Spherical geometry, water reflected.

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[2] Note: In the following sections, results tagged with "(a)" correspond to SCALE 4.4 on the Sun platform; those tagged "(b)" correspond to SCALE 4.4a on the PC platform.

[3] ANSI/ANS-8.1–1998 allows the range of applicability to be extended beyond this range by extrapolating the trends established for the bias; however, no precise guidelines are specified for the limits of extrapolation. Therefore, engineering judgment must be applied when extrapolating beyond the range of the parameter bounds. If extrapolation is necessary, it will be discussed on a case-by-case basis in the individual criticality calculations.

Figure 6–4 shows the calculated k_{eff} values and the parameters for the determination of USL-1 and USL-2 based on trending with ^{240}Pu content. This figure shows that the bias (k_{eff}-1.0) is positive and remains constant with an increase in ^{240}Pu content.

The corresponding USLSTATS output listings are included in Attachment 3 for PC values and in Attachment 4 for Sun values.

Table 6-1 and Table 6-2 show that the minimum USL-1 with a 0.05 administrative margin is 0.9402(a)/0.9408(b). The minimum USL-2 is 0.9746(a)/0.9760(b) and the corresponding minimum margin of subcriticality is 0.016(a)/0.015(b) as determined using Method 2 (See Section 3.3). This indicates that the administrative margin (Δk_m=0.05) applied to the USL-1 value is adequate for the AOA(1) application.

6.1.3 Effect of reflectors and absorbers

Concrete, cadmium/water layers and borated concrete materials are used for some AOA(1) design applications as reflector materials or absorbers to reduce the reflector effectiveness or neutron interaction between adjacent fission zones. Experiments with concrete or cadmium/water reflector are included in the full set of experiments used in the calculation of the USL for the AOA(1). Justification for use of this USL is provided in Attachment 6.

For design applications using borated concrete reflectors, the discussion in Attachment 5 provides justification for use of the USL developed here.

6.1.4 Non-parametric analysis

With 191 critical benchmark values, the degree of confidence β for the non-parametric technique described in Section 3.4 is, according to Eq. 3.23:

$$\beta = 1 - 0.95^{191} = 99.994\%$$

Hence, according to Table 3-1, no additional non-parametric margin is required. The smallest computed k_{eff} values for the collection of experiments is 0.9968±0.006282 for the Sun platform and 0.9948±0.006152 for the PC platform. The resulting USLs determined according to the non-parametric technique (Eq. 3.21) with a 5% administrative margin are

$$\text{NPM USL for Sun} = 0.9386$$

$$\text{NPM USL for PC} = 0.9405$$

The non-parametric results are less limiting than those obtained using the USLSTATS methodology. In order to remain consistent with previous analysis, it is recommended that the more conservative USLSTATS results be used in determining the final USL for AOA(1).

6.1.5 Summary of USL for AOA(1) Aqueous Solutions of Pu-nitrate

The minimum USL for the AOA(1) systems is 0.9370. This value reflects a 0.05 administrative margin and 0.0130 calculational bias. The 0.05 administrative margin is adequate since there is a sufficient number of representative benchmark experiments which cover the range of

applicability for the design conditions. This administrative margin is further justified by the results of the USL-2 analysis, which indicates that the 0.05 administrative margin is justified.

Note that the minimum USL has been selected from the essentially identical results from the PC and Sun platforms and from the trending values from the three correlated parameters. However, [10] suggests that the parameter "*with the strongest correlation to the calculated k_{eff} values is to be used for the determination of USL.*" As can be seen from the USLSTATS results in Attachment 3, this approach would result in a higher USL value for AOA(1). The conservative approach adopted here represents additional margin in the validation for this AOA.

6.2 DESIGN APPLICATION (2) – MOX-PELLETS, FUEL RODS, FUEL ASSEMBLIES

Thirty-six experiments are evaluated for this design application. The calculated k_{eff} values are presented in Attachment 2.

Figure 6–5 shows the distribution of the calculated k_{eff}-values for the design application (Group AOA(2) – MOX pellets, fuel rods, and fuel assemblies) for SCALE4.4 on the Sun platform and SCALE 4.4a on the PC platform. The results are analyzed statistically with the USLSTATS computer code using three trending parameters: v^m/v^f, EALF and PuO_2 content. In all cases, the calculated k_{eff} values are normalized by the handbook experimental k-effective values (see Section 3.5).

The EALF range of selected experiments goes from 0.08 eV to 0.91 eV and the range of v^m/v^f goes from 1.1 to 10.75, cf. Table 5-3.

Table 6-3 and Table 6-4 summarize the statistical results of the USLSTATS program. Figure 6–6 through Figure 6–8 show the results graphically.

6.2.1 USL with EALF and v^m/v^f Ratio

Figure 6–6 and Figure 6–7 show the calculated k_{eff} and the values of USL-1 and USL-2, versus the trending parameters EALF and v^m/v^f, respectively.

The corresponding USLSTATS output listings are attached in Attachment 3 for PC values and in Attachment 4 for Sun values.

Table 6-3 and Table 6-4show that the minimum USL-1 with a 0.05 administrative margin is 0.9321(a)/0.9327(b) for trending with EALF and v^m/v^f (EALF from 0.08 to 0.91 and v^m/v^f ratio from 1.1 to 10.75). The minimum USL-2 is 0.9640(a)/0.9659(b) and the corresponding minimum margin of subcriticality is 0.018(a)/0.017(b) as determined using Method 2 (See Section 3.3). This indicates that the administrative margin (Δk_m=0.05) applied in the USL-1 analysis is adequate for the AOA(2) application provided the EALF and v^m/v^f ratio fall within the applicable range.[4]

[4] ANSI/ANS-8.1 allows the range of applicability to be extended beyond this range by extrapolating the trends established for the bias. If extrapolation is necessary, it will be discussed on a case-by-case basis in the individual criticality calculations.

6.2.2 USL with PuO_2 content in MOX

The 36 experiments are also analyzed as a function of the $PuO_2/(UO_2+PuO_2)$ ratio to evaluate the effect of PuO_2 content on the calculational bias. These 36 experiments cover a range from 1.5 wt. % to 6.6 wt. % in $PuO_2/(UO_2+PuO_2)$. Figure 6–8 shows the calculated k_{eff} values and the USL parameters for the determination of USL-1 and USL-2 based on trending with PuO_2 content.

Table 6-3 and Table 6-4 show that the minimum USL-1 with a 0.05 administrative margin is 0.9378(a)/0.9378(b). This administrative margin is further justified by the results of the USL-2 analysis which indicates that an adequate minimum margin of subcriticality for this AOA is 0.018(a)/0.017(b), significantly less than the 0.05 administrative margin actually used.

6.2.3 Effect of reflectors and absorbers

Concrete and borated shields are used for some AOA(2) design application as reflectors or to reduce reflector effectiveness and neutron interaction between adjacent fission zones. For these design applications, a case-by-case argument will be provided in the respective calculation justifying use of the USL.

6.2.4 Summary of USL for AOA(2) MOX pellets, fuel rods, and fuel assemblies

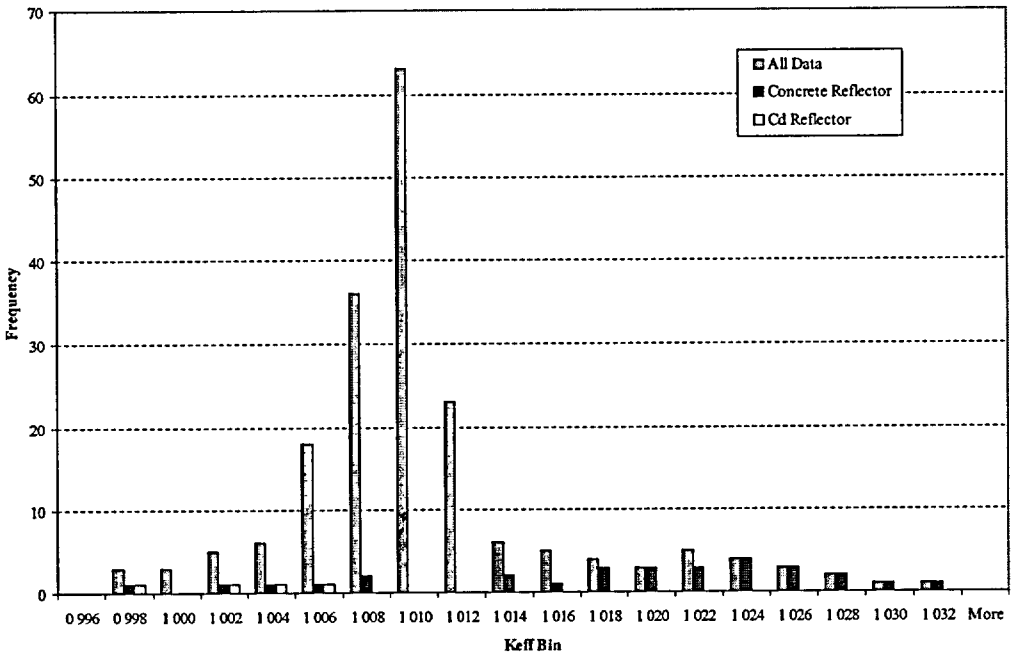
The minimum USL for the AOA(2) systems is 0.9321. This value reflects a 0.05 administrative margin and 0.0179 calculational bias. The 0.05 administrative margin is more than adequate since there is an adequate number of representative benchmark experiments which cover the range of applicability for the design conditions.

This administrative margin is further justified by the results of the USL-2 analysis which indicates that an adequate minimum margin of subcriticality for this AOA is 0.018, significantly less than the 0.05 administrative margin actually used.

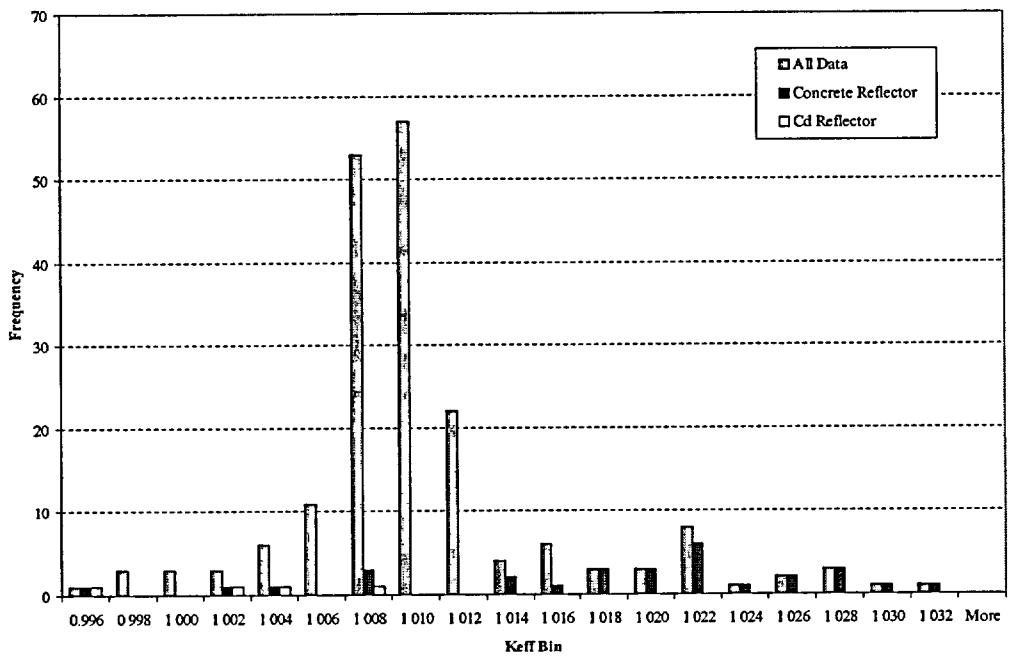
Note that the minimum USL has been selected from the essentially identical results from the PC and Sun platforms and from the trending values from the three correlated parameters. However, [10] suggests that the parameter "*with the strongest correlation to the calculated k_{eff} values is to be used for the determination of USL.*" As can be seen from the USLSTATS results in Attachment 4, this approach would result in a higher USL value for AOA(2). The conservative approach adopted here represents additional margin in the validation for this AOA.

Note that the benchmark experiments for clad fuel pellets are directly applicable to the production of fuel assemblies and configurations involving loose rods. The application calculations for these configurations are within the AOA as derived from the benchmark experiments. These benchmark experiments are also directly applicable to unclad fuel pellets or loose pellets since the cladding effects (neutronic absorption in the epithermal and thermal regions) are negligible. The cladding configuration (material, position and thickness) in these experiments changes the epithermal and thermal neutron flux distribution by less than 1% at the surface of the pellet (comparison of clad pellets as compared to unclad pellets). A 1% change in the epithermal and thermal flux distribution at the surface of the pellet leads to a significantly smaller change in the k_{eff} of the system since all neutrons transgressing the surface of the pellet do not lead to fission. The neutron flux difference would generally result in a Δk_{eff} (between

clad and unclad pellets) of 0.005, which is on the order of the KENO variance. Based on this difference, the AOA for clad fuel pellets, fuel assemblies or loose rods is directly applicable to unclad pellets. Pellet configurations and application calculations within the AOA range established by benchmark experiments for clad rods are directly applicable to pellets and are therefore appropriately validated.

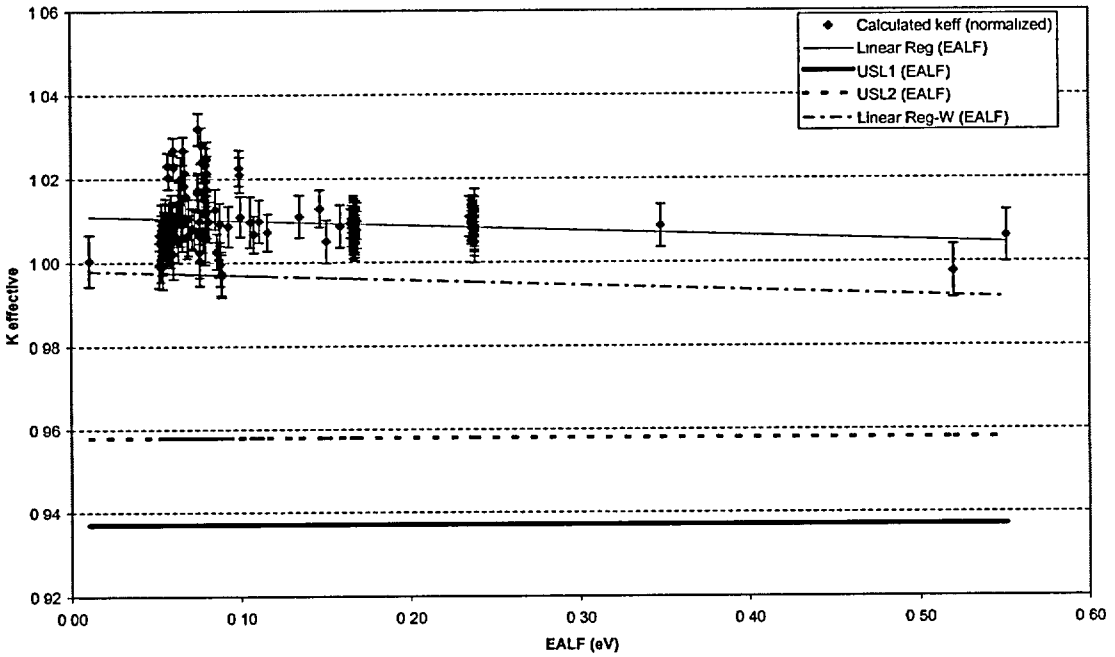


(a) Sun Platform – SCALE 4.4

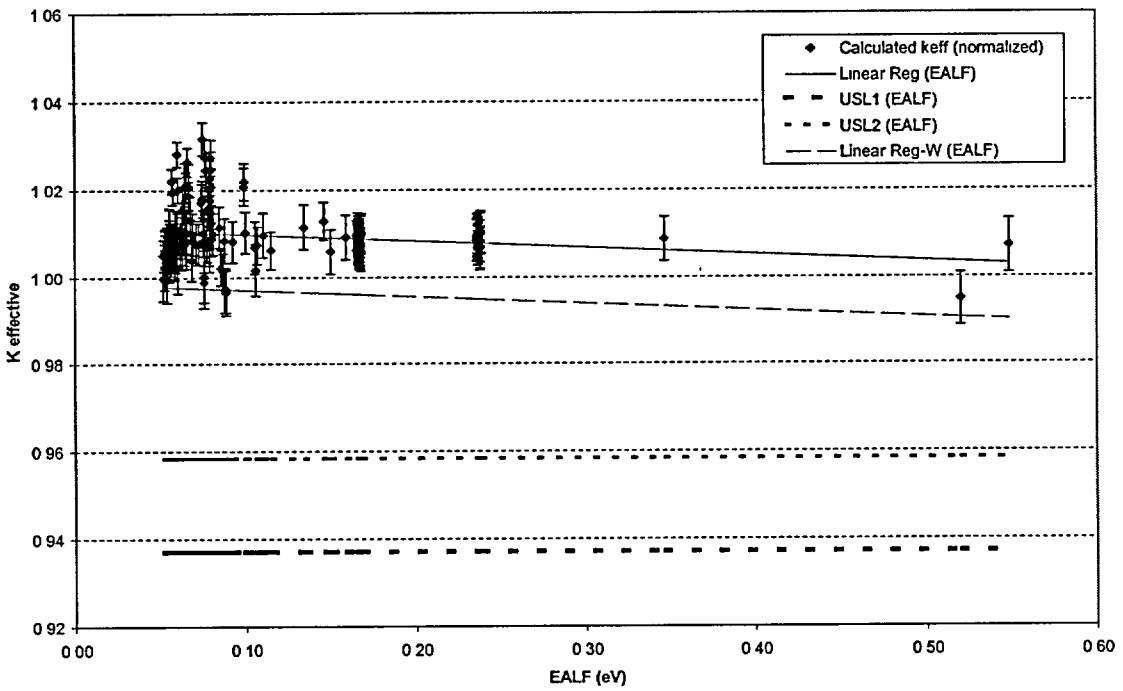


(b) PC Platform – SCALE 4.4a

Figure 6–1 Histogram of normalized k_{eff} values for AOA(1) on Sun (a) and PC (b) platforms

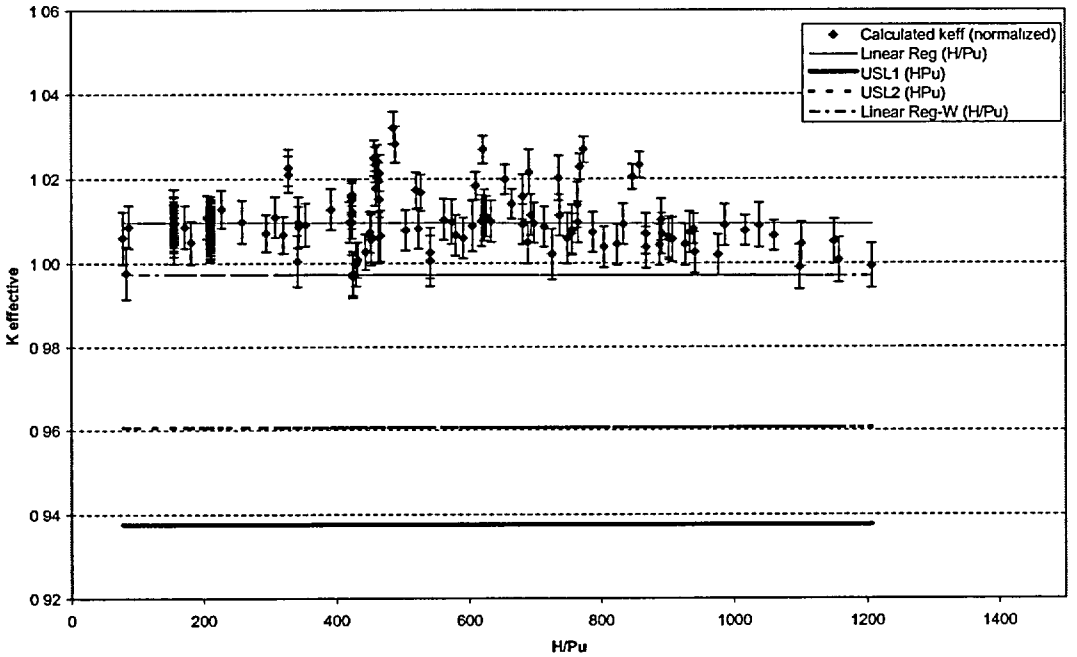


(a) Sun Platform – SCALE 4.4

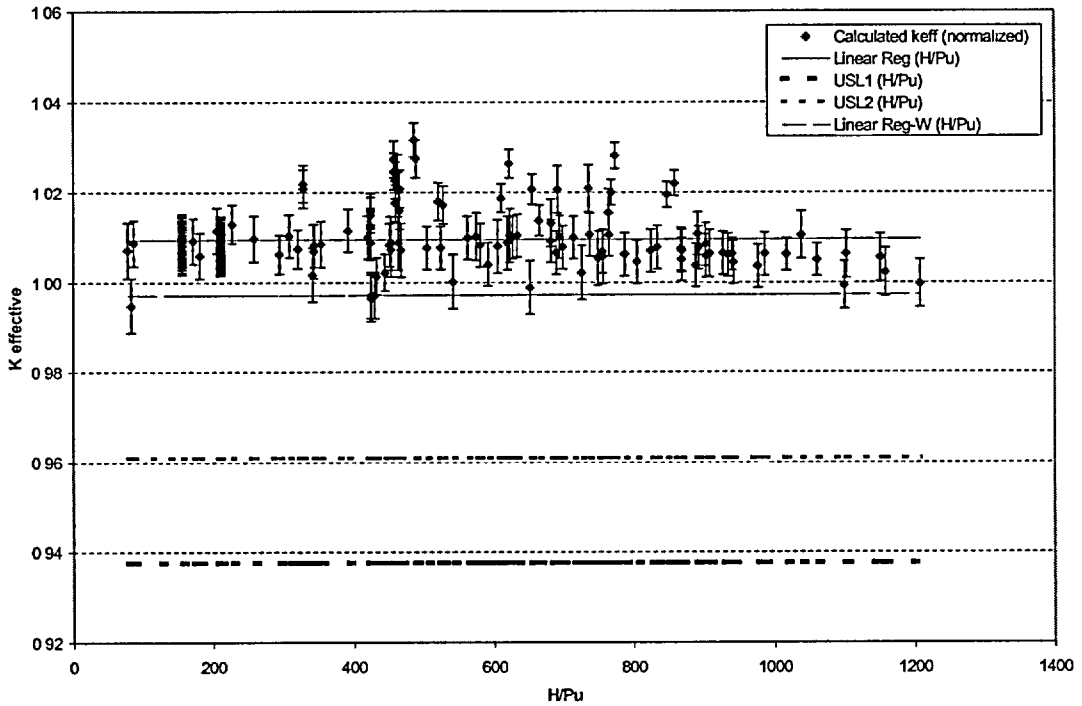


(b) PC Platform – SCALE 4.4a

Figure 6–2 AOA(1) – Pu-nitrate solution; k_{eff} as function of EALF

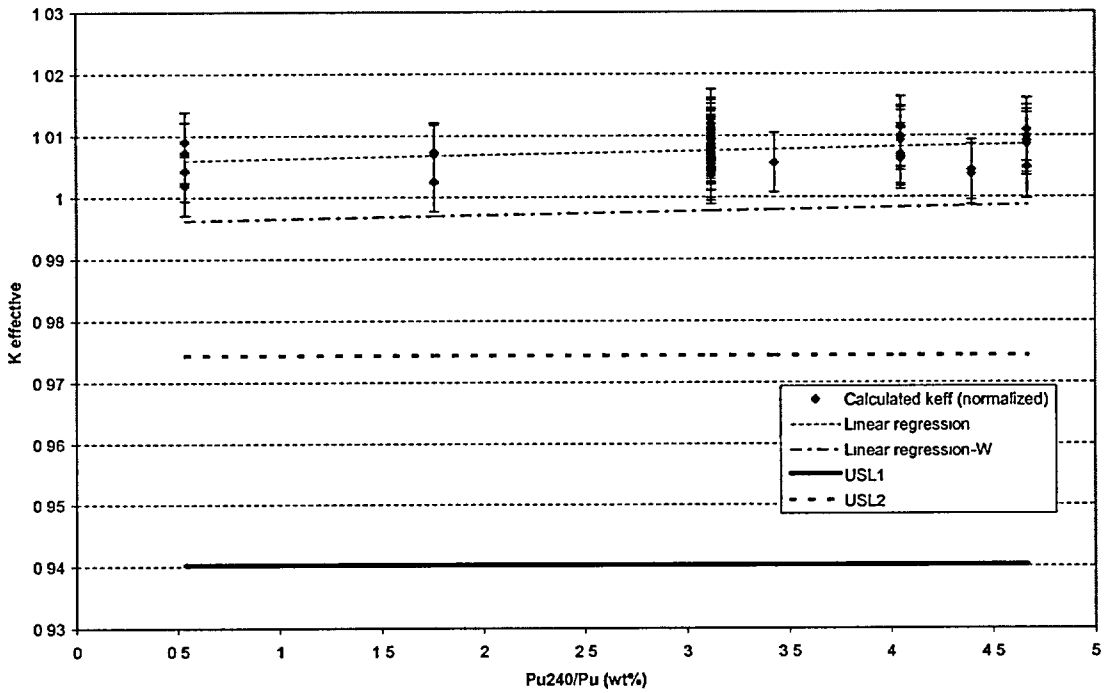


(a) Sun Platform – SCALE 4.4

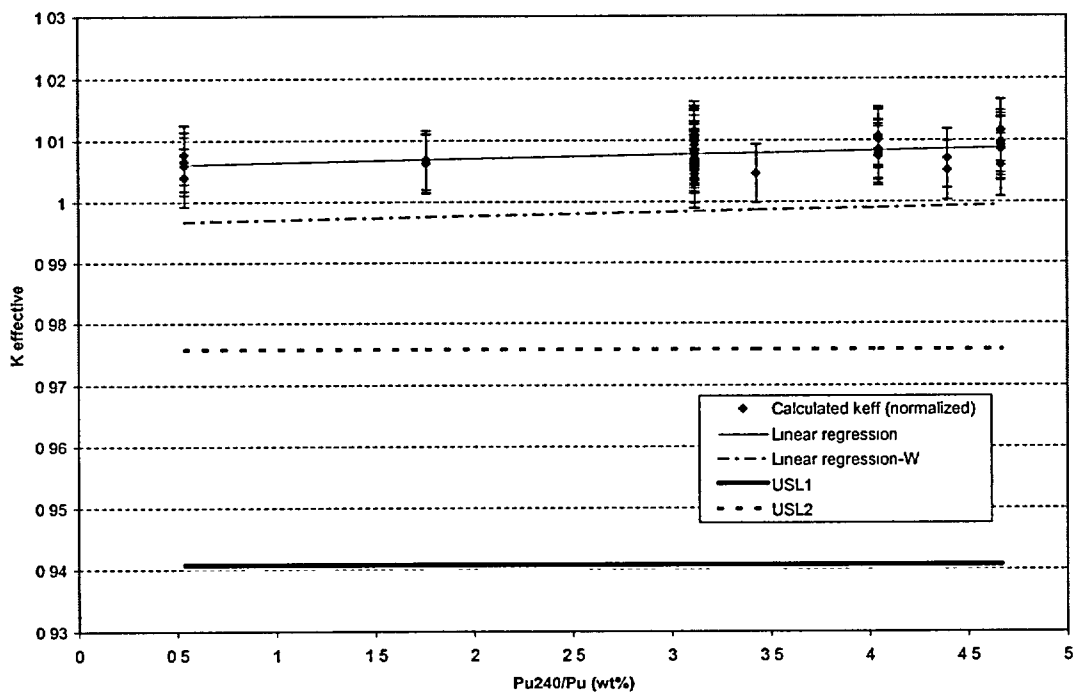


(b) PC Platform – SCALE 4.4a

Figure 6–3 AOA(1) – Pu-nitrate solution; k_{eff} as function of H/Pu

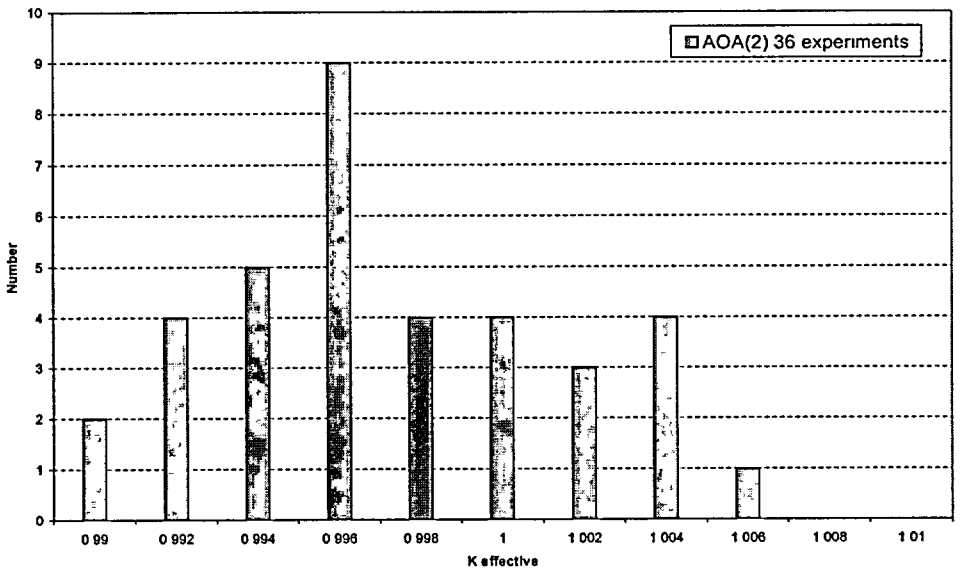


(a) Sun Platform – SCALE 4.4

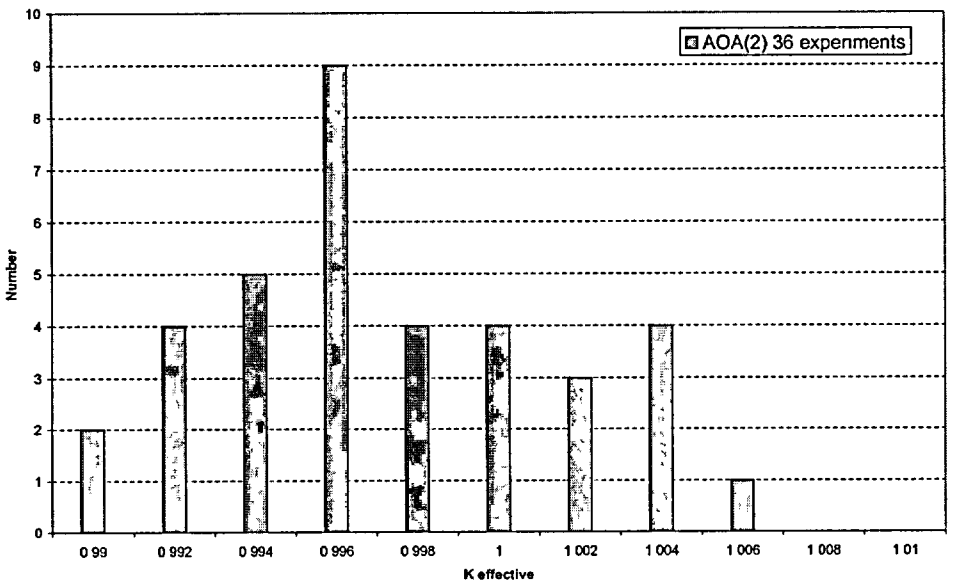


(b) PC Platform – SCALE 4.4a

Figure 6–4 AOA(1) – Calculated k_{eff} as function of ^{240}Pu content

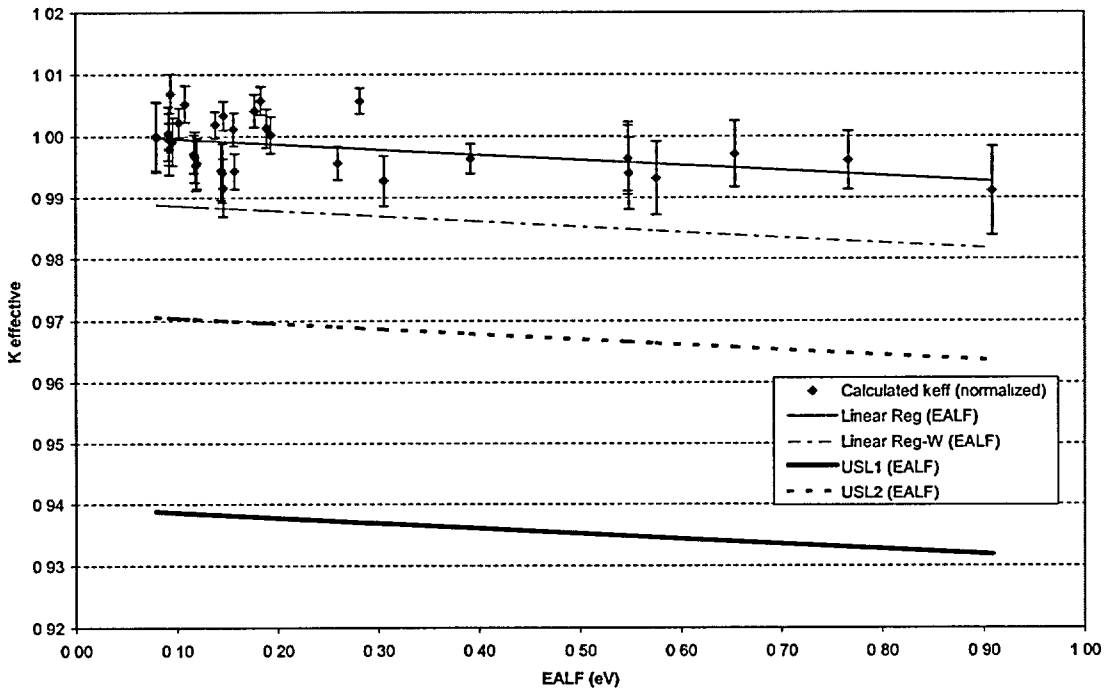


(a) Sun Platform – SCALE 4.4

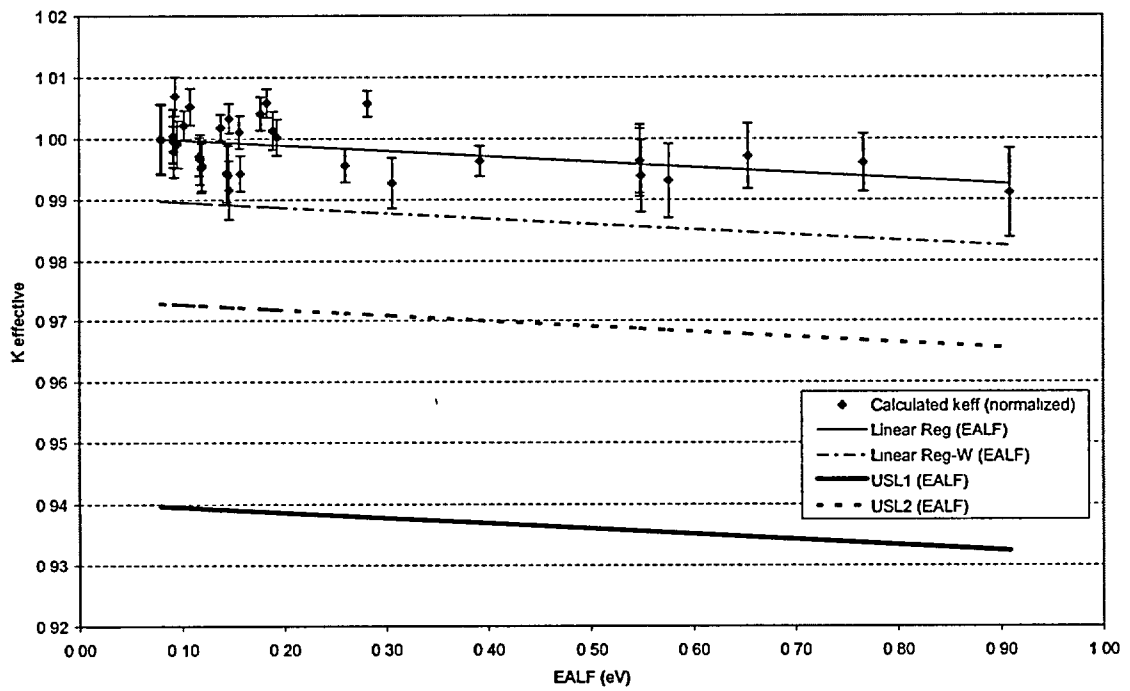


(b) PC Platform – SCALE 4.4a

Figure 6–5 Histogram of normalized k_{eff} values for AOA(2) on Sun (a) and PC (b) platforms

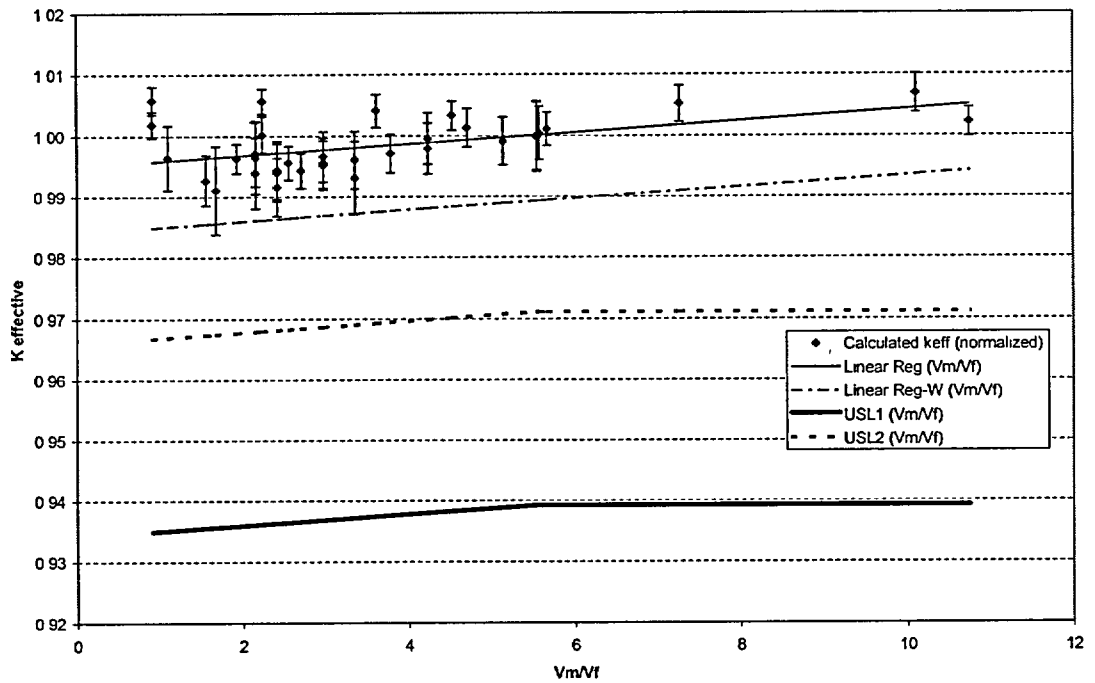


(a) Sun Platform – SCALE 4.4

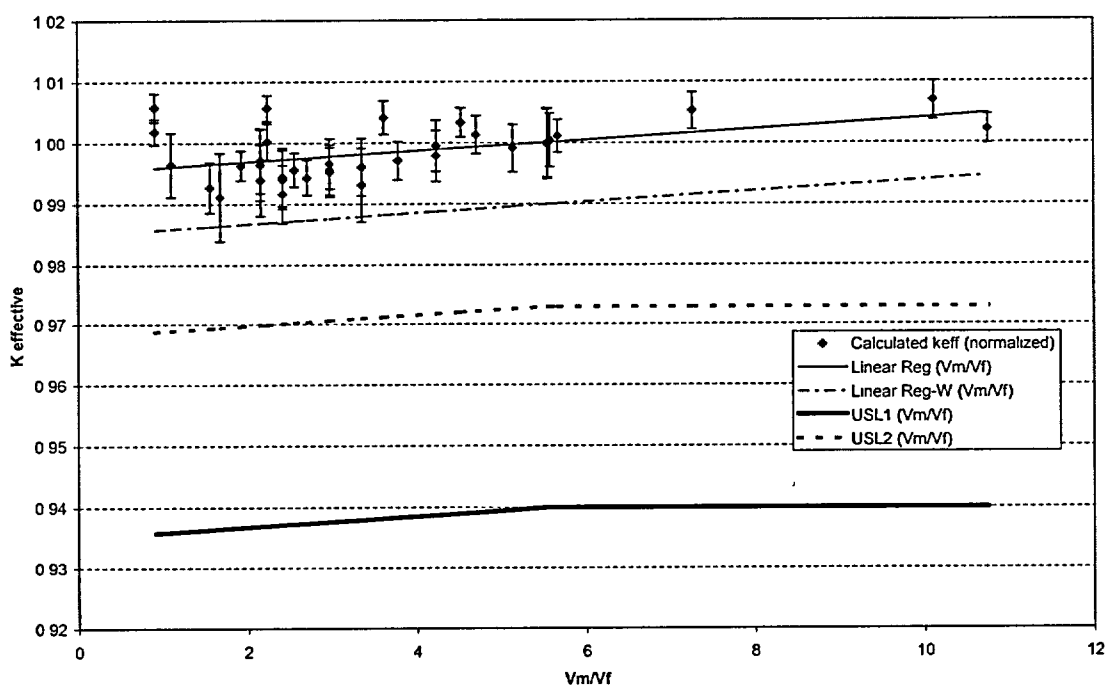


(b) PC Platform

Figure 6–6 AOA(2) – MOX pellets, fuel rods and fuel assemblies: k_{eff} as function of EALF

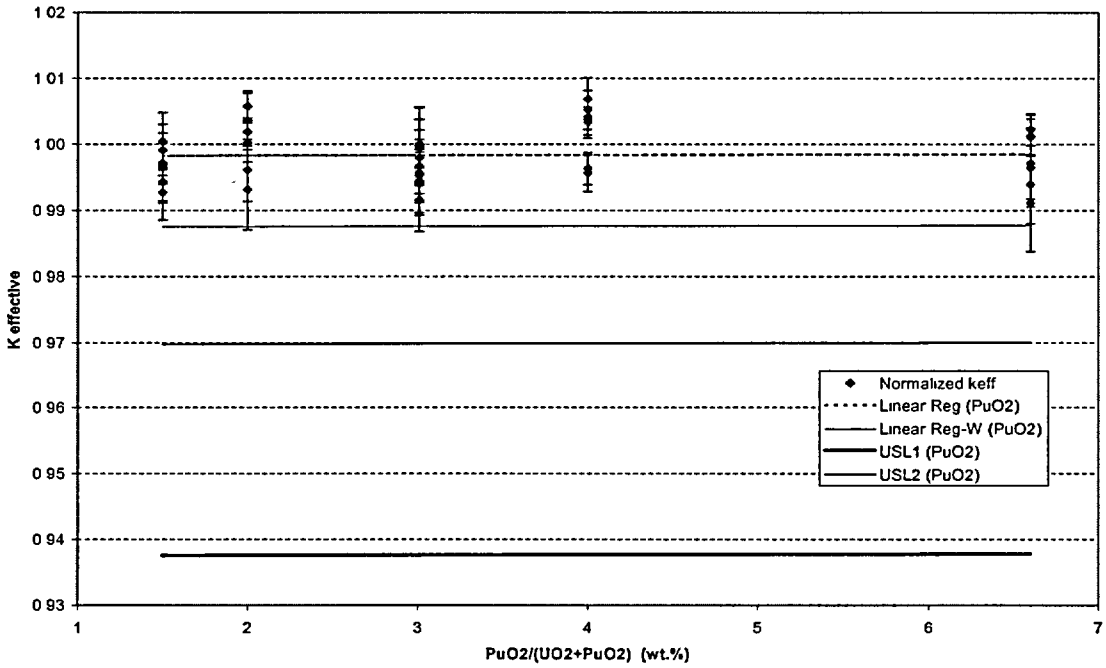


(a) Sun Platform – SCALE 4.4

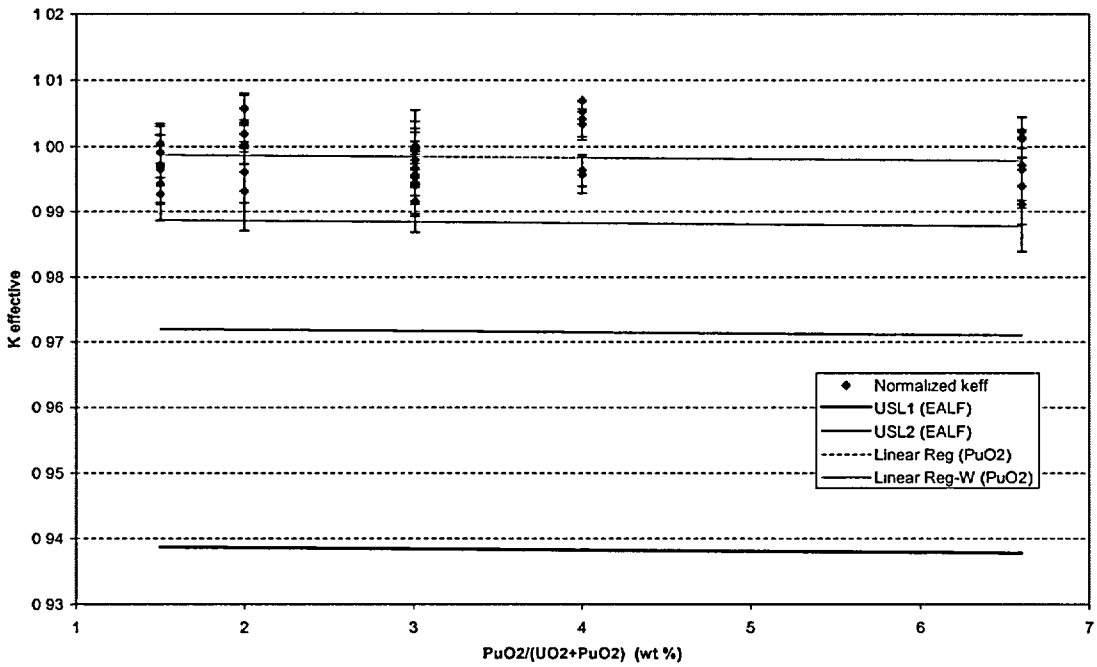


(b) PC Platform – SCALE 4.4a

Figure 6–7 AOA(2) – MOX pellets, fuel rods and fuel assemblies: k_{eff} as function of v^m/v^f



(a) Sun Platform



(b) PC Platform

Figure 6–8 AOA(2) – MOX pellets, fuel rods and fuel assemblies: k_{eff} as function of PuO_2 content

Table 6-1 Summary of USL Calculations for SCALE 4.4 on Sun Platform: AOA(1)

Correlated Parameter (x)	No. Exps.	Range of x	$k_c(x)$ Linear Regression	Average k_c	Min USL_1 (Δk_m =0.05)	Min USL_2	Min Δk_m (USL_2)
EALF (eV)	191	0.05 to 0.55	1.0113 + (-1.2867E-02)*x	1.0096	0.9370	0.9581	0.029
H/Pu	191	85 to 1157	1.0096 + (1.7495E-07)*x	1.0096	0.9376	0.9607	0.027
^{240}Pu (wt. %)	46	0.54 to 4.67	1.0057 + (6.1803E-04)*x	1.0077	0.9402	0.9746	0 016

Table 6-2 Summary of USL Calculations for SCALE 4.4a on PC Platform: AOA(1)

Correlated Parameter (x)	No. Exps.	Range of x	$k_c(x)$ Linear Regression	Average k_c	Min USL_1 (Δk_m =0.05)	Min USL_2	Min Δk_m (USL_2)
EALF (eV)	191	0.05 to 0.55	1.0114 + (-1.5297E-02)*x	1.0095	0.9372	0.9585	0.029
H/Pu	191	85 to 1157	1.0091 + (8.1036E-07)*x	1.0095	0.9377	0.9610	0.027
^{240}Pu (wt. %)	46	0.54 to 4.67	1.0048 + (9.2819E-04)*x	1.0078	0.9408	0.9760	0.015

Table 6-3 Summary of USL Calculations for SCALE 4.4 on Sun platform: AOA(2).

Correlated Parameter (x)	No. Exps.	Range of x	$k_c(x)$ Linear Regression	Average k_c	Min USL_1 (Δk_m =0.05)	Min USL_2	Min Δk_m (USL_2)
EALF (eV)	36	0.08 to 0.91	1.0005 + (-8.4182E-03)*x	0.9984	0.9321	0.9640	0.018
v^m/v^f	36	1.1 to 10.75	0.9939 + (1.2243E-03)*x	0.9984	0.9351	0.9681	0.017
$PuO_2/(UO_2+PuO_2)$ (wt. %)	36	1.5 to 6.6	0.9985 + (-2.3845E-05)*x	0.9984	0.9378	0.9701	0.018

Table 6-4 Summary of USL Calculations for SCALE 4.4a on PC platform: AOA(2).

Correlated Parameter (x)	No. Exps.	Range of x	$k_c(x)$ Linear Regression	Average k_c	Min USL_1 (Δk_m =0.05)	Min USL_2	Min Δk_m (USL_2)
EALF (eV)	36	0.08 to 0.90	1.0007 + (-8.7123E-03)*x	0.9985	0.9327	0.9659	0.017
v^m/v^f	36	1.1 to 10.75	0.9941 + (1.1733E-03)*x	0.9985	0.9359	0.9700	0.016
$PuO_2/(UO_2+PuO_2)$ (wt. %)	36	1.5 to 6.6	0.9994 + (-2.5117E-04)*x	0.9985	0.9378	0.9712	0.017

7. CONCLUSIONS

The SCALE 4.4 and SCALE 4.4a code packages using the CSAS26 (KENOVI) sequence and the 238 energy group cross section library 238GROUPDF5 have been validated to perform criticality calculations for the Mixed Oxide Fuel Fabrication Facility. The validation covers two of the facility design areas of applicability: AOA(1) Pu-nitrate solutions and AOA(2) MOX pellets, rods, and fuel assemblies.

The USL for the two design application areas are as follows:

- Design application (1) Pu-nitrate solutions USL AOA(1) = 0.9370
- Design application (2) MOX pellets, rods, and fuel assemblies USL AOA(2) = 0.9321

The USL accounts for the computational bias, uncertainties, and an administrative margin. The administrative margin is established at 0.05 such that $k_{eff} + 2\sigma - bias \leq 0.95$ for all normal and credible abnormal conditions. Section 7.1 contains a detailed justification of the administrative margin.

No extrapolation outside the range of applicability is expected for the AOA(1) and AOA(2) USL values; however, ANSI/ANS-8.1 [2] does allow for extrapolation outside the area of applicability by extrapolating the trends established for the bias and USL. If extrapolation is necessary, it will be discussed on a case-by-case basis in the respective calculation.

7.1 JUSTIFICATION FOR ADMINISTRATIVE MARGIN

The administrative margin applied in the determination of the USL is intended as an added level of conservatism. The code validation effort accounts for all code bias and the effects of both code and experimental benchmark uncertainties. The administrative margin is applied *in addition* to the code bias and bias uncertainty in determining the USL.

The USL values determined here are based on an administrative margin of 0.05. Based on actual process conditions, including 1) the degree to which application parameters fall within the validated Area of Applicability (AOA) of the calculational method and 2) the results of sensitivity analyses demonstrating the sensitivity of k_{eff} values to variations in controlled parameters, the USL may be adjusted. Each NCSE and criticality calculation will include a discussion of the appropriateness of the USL applied for each specific design application.

Typically, the NCSEs and criticality calculations will present k_{eff} results for various scenarios, including normal operation and credible abnormal situations. The results of these analyses permit a quantitative assessment of the degree of subcriticality of the system measured in terms of variation of one or more controlled parameters. Hence, the NCSEs/criticality calculations for specific design applications will verify the conformance with the AOA used in the validation reports.

In general, based on the discussion below, the administrative margin used in criticality analyses is 0.05. This assessment is based on a comparison against administrative margin practices at both NRC and DOE facilities, and past NRC guidance and practice, and is further substantiated by a statistical analysis of the benchmark validation results.

7.1.1 Fuel Cycle and Industry Practice

A review of NRC materials licensees and analogous DOE facilities (including plutonium facilities) indicates that administrative margins range from 0.02 to 0.05 as shown in Table 7-1. These values apply to applications within the validated AOAs; adjustments to the administrative margin are typically made for application outside the validated region.

These values are consistent with precedent information provided by the NRC Staff [20], which indicates administrative margins with a similar range to those indicated in Table 7-1.

An administrative margin of 0.05 is greater than or equal to the most conservative margins identified in Table 7-1 and other NRC precedent [20] for analysis of credible abnormal conditions.

This margin is consistent with guidance provided in NUREG-1718 [3], which supports an administrative margin of 0.05 for the MFFF. It is also consistent with past NRC-accepted practice in reactor operations (10 CFR 50) [19], and transportation (10 CFR 71) and on-site storage (10 CFR 72) of spent nuclear fuel. Examination of various precedents indicates 0.05 is a conservative administrative margin for activities falling within the validated AOA. For criticality analyses applied outside the validated AOA, specific guidance is provided in ANSI/ANS–8.1–1998 which indicates that the administrative margin may be adjusted based on established trends in the bias, if necessary.

7.1.2 USLSTATS Method 2 Quantitative Assessment

Once an administrative margin has been determined (in this case, based on NRC guidance in NUREG-1718 [3] and based on conservative comparison with applicable precedent), NUREG/CR-6361 [10] provides a quantitative method of assessing the suitability of the administrative margin based on a statistical analysis which generates a recommended minimum margin of subcriticality. NUREG/CR-6361 suggests that this minimum margin of subcriticality be compared against the administrative margin in order to verify that the administrative margin is conservative relative to a purely statistical basis[5].

This mechanism provides an independent, quantitative means of substantiating the administrative margin selected based on the statistics of the benchmarks themselves. The use of this methodology requires the specification of two important statistical parameters: α, the level of confidence in the limit being calculated and P, the probability future calculations will lie within the statistical band. The result of this methodology is the assurance that by using at least the calculated minimum margin of subcriticality, there is a probability P with a confidence α that an additional calculation of k_{eff} for a critical system will lie within the band. For example, a calculation with α=0.95 and P=0.95 would yield a USL for which there is a 95% confidence that 95 out of 100 future calculations of critical systems will yield a value of k_{eff} above the USL (which is conservative). This level of statistical treatment is consistent with the statistics usually employed in the inclusion of 2σ in the treatment of Monte Carlo criticality calculations. It is also

[5] See NUREG/CR-6361 §4.1.3. For example, Westinghouse is approved to use a 0.02 Δk administrative margin unless a higher margin of subcriticality is calculated using USL–2 methodology.

consistent with the statistical recommendations in NUREG/CR-6698 [18]. As can be seen in the figures in Section 6, use of this traditional statistical treatment would lead to the conclusion that, based on the usual statistical approach, a margin as low as 0.01 to 0.02 would be necessary to ensure that the USL was conservative based upon a statistical evaluation of the data.

However, this report uses USLSTATS to examine the statistics at a higher level of certainty. That is, values of α=0.95 and P=0.999 were used. This means that the derived USL–2 is such that there is a 95% confidence that 999 out of 1000 future calculations of critical systems will yield a value of k_{eff} above the USL. The resulting conclusion using 95/99.9 statistics is that the added conservatism over the 1-2% amount, which would be required using traditional statistical levels, is available to ensure that the results are conservative for other potential mechanisms for which conservatisms would be prudent.

An analysis of the benchmarks using a value of α=0.95 and P=0.999 yield the subcritical margins listed in Table 7-2. If one were to base an administrative margin solely on this very conservative statistical analysis, an administrative margin of at most 0.03 is necessary to statistically justify the use of these benchmarks. This is significantly less than the 0.05 administrative margin used for the two AOAs. Note that the administrative margin is applied in addition to the calculated bias and uncertainty for each AOA. This means that the proposed 0.05 administrative margin is still more conservative than that determined in the 95/99.9 statistical treatment and is justified in the MFFF.

7.1.3 Summary of Administrative Margin Practice

This effort involves the validation of the code to applications within one or more specific areas of applicability. There is no intent to account for or to address the uncertainties and unknowns involved in the actual design applications. This approach is consistent with NUREG/CR-6698 which states "*the subcritical margin is not intended to account for process upset conditions or for uncertainties associated with a process.*" These issues are properly addressed in the nuclear criticality safety evaluations (NCSEs). These evaluations will demonstrate that the design application falls within the required AOA, that design uncertainties and unknowns are properly and conservatively addressed, that sensitivity to controlled parameters is adequately addressed, and that the criticality models themselves are suitably conservative representations of the actual physical phenomena. In cases where calculated k_{eff} values are shown to be sensitive to controlled parameters, the NCSE will demonstrate the adequacy of the control.

In conclusion, an administrative margin of 0.05, selected on the basis of NRC guidance and conservative comparison with applicable precedent, and substantiated through statistical methods, is justified, and is sufficiently conservative to provide for an adequate margin of subcriticality.

Table 7-1 Fuel Cycle and Industry Practice

Facility	Process/Application	Material	Administrative Margin
Framatome Cogema Fuels	Fuel assembly manufacture	Low enriched U	0.05
Westinghouse Columbia Site	Fuel assembly manufacture	Low enriched U	0.02
Nuclear Fuel Services	Fuel processing (solutions, powder, pellets, etc.)	Various U enrichments	0.03 LEU 0.05 HEU
Paducah Uranium Enrichment Plant	Uranium enrichment	Low enriched U	0.02
Rocky Flats	Weapons material processing	Plutonium	0.03
BWXT	Fuel assembly manufacture	Low to High Enriched U	0.03 LEU 0.05 HEU
Savannah River Site	a) MTR fuel assemblies b) Pipe overpack material storage c) Mark 42 tube dissolution d) Ion exchange columns with fissile solutions e) DDF-1 package	a) High enriched U b) ^{239}Pu c) ^{239}Pu d) ^{239}Pu solution e) Pu metal and oxide	a) 0.02 b) 0.02 c) 0.05 d) 0.04 e) 0.05
Y-12	Weapons material processing	High enriched U	0.02 – 0.05[1]
Idaho National Engineering and Environmental Lab	Solutions/spent fuel/powders/pieces	Low to High Enriched U, including ^{233}U;some Pu	0.02 – 0.05 0.05 typical
Hanford Site	Waste tanks Packaging and transportation	Various	0.05

[1] Pending final approval of validation document.

Table 7-2 USLSTATS Method 2 Analysis Results

Area of Applicability	USL-2 Minimum Margin of Subcriticality	Administrative Margin	Factor By Which Admin Margin Exceeds Recommended Value
AOA(1)	0.029	0.050	1.7
AOA(2)	0.018	0.050	2.7

8. REFERENCES

[1] SCALE 4.4 : A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation, NUREG/CR-0200 (ORNL/NUREG/CSD-2/R6), Volumes I, II and III. Available from Radiation Shielding Information Center as CCC-545.

[2] ANSI/ANS (American National Standards Institute/American Nuclear Society), 1998. American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/ANS–8.1–1998, La Grange Park, IL.

[3] NRC (U.S. Nuclear Regulatory Commission), 2000. Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility, NUREG-1718, U.S. Nuclear Regulatory Commission, Washington, DC.

[4] DV/CDT/9003/055/V Verification of the SCALE4.4 Code Package at the Sun Work Station, SGN Document NT 12046 00 029 A.

[5] Verification of the SCALE 4.4a Code Package on SGN Pentium PCs, SGN Document NT 12046 00 028 A.

[6] Nuclear Energy Agency, 1999. International Handbook of Evaluated Criticality Safety Benchmark Experiments, NEA/NSC/DOC(95)03, Nuclear Energy Agency, Organization for Economic Co-operation and Development.

[7] Emmett, M.B., and W.C. Jordan, 1996, Guide to Verification and Validation of the SCALE-4 Criticality Safety Software, NUREG/CR-6483 (ORNL/TM-12834), Lockheed Martin Energy Research Corp., Oak Ridge National Laboratory, Oak Ridge, TN.

[8] Neutronics Benchmarks for the Utilization of Mixed-Oxide Fuel: Joint U.S./Russian Progress Report for Fiscal Year 1997, Prepared by the Staffs of the Oak Ridge National Laboratory and the Amarillo National Research Center for Plutonium, Coordinated in the U.S. by R.T. Primm III, ORNL/TM-13603/V2, March 1999.

[9] ANSI/ANS (American National Standards Institute/American Nuclear Society), 1984. Criticality Safety Criteria for Handling Storage, and Transportation of LWR Fuel Outside Reactors, ANSI/ANS-8.17, La Grange Park, IL.

[10] Lichtenwalter, J.J., S.M. Bowman, M.D. DeHart, and C.M. Hopper, 1997. Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage Packages, NUREG/CR-6361 (ORNL/TM-13211), Lockheed Martin Energy Research Corp., Oak Ridge National Laboratory, Oak Ridge, TN.

[11] Dyer, H.R., W.C. Jordan, and V.R. Cain, 1991. A Technique for Code Validation for Criticality Safety Calculations, Trans. Am. Nucl. Soc. 63, 238 (June 1991).

[12] Easter, M.E., 1985. Validation of KENO V.a and Two Cross-Section Libraries for Criticality Calculations of Low-Enriched Uranium Systems, ORNL/CSD/TM-223, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1985.

[13] Bowden D.C. and F.A. Graybill, 1966. Confidence Bands of Uniform and Proportional Width for Linear Models, Am. Stat. Assoc. J. 61, 182 (March 1966).

[14] Johnson, N.L.,1968. Ed., Query, Technometrics 10, 207-209 (February 1968).

[15] Cain, V.R., 1995. A Computer Code to Perform Analyses of Criticality Validation Results, Y/DD-574, Martin Marietta Energy Systems, Inc., Oak Ridge Y-12 Plant, September 1995.

[16] DCS01 ZJJ CG CAL H 06329 B Validation of SCALE 4.4 and SCALE 4.4a for Application to the MOX Fuel Fabrication Facility Using the 238 Group ENDF/B-V Cross Section Library Part II: AOA(3) PuO_2 powder, AOA(4): MOX powder.

[17] Validation of SCALE 4.4 and SCALE 4.4a for Application to the MOX Fuel Fabrication Facility Using the 238 Group ENDF/B-V Cross Section Library Part III: AOA(5) Aqueous solution of Pu compounds, Document in preparation.

[18] J.C. Dean, R.W. Tayloe, Jr., "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," NUREG/CR-6698, Science Applications International Corporation, Oak Ridge, TN, January 2001.

[19] NRC Memorandum, L. Kopp to T. Collins, "Guidance on the regulatory requirements for criticality analysis of fuel storage at light-water reactor power plants," August, 1998.

[20] NRC Letter, A. Persinko to P.S. Hastings, "Nuclear Criticality Safety Staff Qualifications and Administrative Margins for Fuel Fabrication Facilities," 09 November 2001.

ATTACHMENT NUMBER 1

CRITICALITY CALCULATION RESULTS FOR AOA(1)

ICSBEP Pu-Nitrate Solution Benchmarks

The ICSBEP Handbook [6] includes a number of experiments related to Pu-nitrate solutions. However, some of these experiments were determined to be inapplicable to MFFF design applications within AOA(1). The list below provides the reasoning for inclusion or exclusion of each candidate experiment.

PU-SOL-THERM-001: All cases are selected.

PU-SOL-THERM-002: All cases are selected.

PU-SOL-THERM-003: All cases are selected.

PU-SOL-THERM-004: All cases are selected.

PU-SOL-THERM-005: All cases are selected.

PU-SOL-THERM-006: All cases are selected.

PU-SOL-THERM-007: This benchmark is not selected because the experiment is very similar to the PU-SOL-THERM-001 benchmark experiment, except the spheres are only partly flooded. The partial flooding introduces an unnecessary geometric complexity.

PU-SOL-THERM-008: This experiment is selected, and is of interest due to the presence of concrete reflectors. Note that Case 6 is omitted since the benchmark evaluation recommends it not be used.

PU-SOL-THERM-009: This benchmark is not selected because the ICSBEP calculated k_{eff}-values are not in good agreement with the experimental k_{eff} (higher values) and the experiments do not add new relevant information (spherical geometry, ^{240}Pu ratio = 2.5 % ^{240}Pu).

PU-SOL-THERM-010: This benchmark is not selected because the ICSBEP calculated k_{eff} values are not in good agreement with the experimental k_{eff} and the experiments do not add relevant information (spherical geometry, reflected by natural uranium, ^{240}Pu ratio = 2.8 %).

PU-SOL-THERM-011: All cases are selected.

PU-SOL-THERM-012: This benchmark is not selected because the ^{240}Pu ratio is not in range (^{240}Pu ratio = 19%).

PU-SOL-THERM-013: This benchmark is not selected because the experiments do not add additional relevant information (Interacting cylinders, ^{240}Pu ratio = 4.23 %)

PU-SOL-THERM-014: All cases are selected.

PU-SOL-THERM-015: All cases are selected.

PU-SOL-THERM-016: All cases are selected.

PU-SOL-THERM-017: All cases are selected.

PU-SOL-THERM-020: All cases except Case 4 are selected. The benchmark evaluation recommends against using Case 4: "this case is considered to be undesirable as a benchmark configuration, and is not accepted." [6, PU-SOL-THERM-020, p. 20]

PU-SOL-THERM-021: This benchmark is not selected because the experiments do not add additional relevant information (spherical geometry, ^{240}Pu ratio = 4.57 % ^{240}Pu).

PU-SOL-THERM-022: This benchmark is not selected because the ^{240}Pu ratio is not in range (^{240}Pu ratio = 19%).

PU-SOL-THERM-023: Not considered for inclusion in this report due to excessive complexity in the geometric and material descriptions.

PU-SOL-THERM-024: This benchmark is not selected because the ^{240}Pu ratio is not in range (^{240}Pu ratio = 18.4% to 23.2%).

PU-SOL-THERM-025: Cases1 to 6 are selected (^{240}Pu = 4.67%).

PU-SOL-THERM-026: Cases 1 to 3 are selected (^{240}Pu = 4.6%).

ATTACHMENT NUMBER 1A

AOA(1) CRITICALITY RESULTS ON SUN PLATFORM

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-001											
Case 1	73.00	352 91	4 67	1.0000	0.005	1.0091	0 0011	8.79E-02	600	1500	13
Case 2	96 00	258.05	4 67	1.0000	0.005	1.0098	0 0010	1.11E-01	600	1500	15
Case 3	119.00	205.14	4 67	1.0000	0.005	1.0109	0 0011	1.35E-01	600	1500	21
Case 4	132.00	180 97	4 67	1.0000	0.005	1 0049	0 0011	1.51E-01	600	1500	20
Case 5	140 00	171.21	4 67	1.0000	0 005	1 0086	0 0010	1.59E-01	600	1500	20
Case 6	268 70	86 66	4 67	1.0000	0 005	1.0086	0 0011	3 48E-01	600	1500	22
PU-SOL-THERM-002											
Case 1	50 32	507.98	3 12	1.0000	0 0047	1.0082	0 0011	7.12E-02	600	1500	16
Case 2	51.80	489.18	3.12	1.0000	0 0047	1.0078	0 0011	7.29E-02	600	1500	19
Case 3	56 48	437.28	3 12	1.0000	0 0047	1.0073	0 0011	7.78E-02	600	1500	11
Case 4	60.14	407.45	3 12	1.0000	0 0047	1.0097	0 0011	8 15E-02	600	1500	14
Case 5	63.96	380.57	3 12	1.0000	0 0047	1.0127	0 0010	8 51E-02	600	1500	16
Case 6	70 22	333.54	3.12	1.0000	0 0047	1.0086	0 0011	9 29E-02	600	1500	85
Case 7	77.22	299.26	3.12	1 0000	0 0047	1.0109	0 0011	1.00E-01	600	1500	25
PU-SOL-THERM-003											
Case 1	33 62	774 15	1.76	1.0000	0 0047	1.0073	0.0009	5.84E-02	600	1500	12
Case 2	34.70	742 71	1.76	1 0000	0 0047	1.0070	0.0010	5.96E-02	600	1500	75
Case 3	38 05	677.17	3.12	1 0000	0 0047	1.0095	0.0009	6 18E-02	600	1500	25
Case 4	38.83	660 55	3.12	1.0000	0 0047	1.0092	0.0010	6 27E-02	600	1500	17
Case 5	40.90	607.17	3.12	1.0000	0 0047	1.0110	0.0010	6 54E-02	600	1500	22
Case 6	44.38	545 33	3.12	1 0000	0 0047	1.0103	0.0012	6 94E-02	600	1500	12
Case 7	36.27	714 83	3.12	1 0000	0.0047	1.0113	0.0011	5.91E-02	600	1500	11
Case 8	37.11	692 12	3.12	1.0000	0 0047	1.0086	0.0010	6 01E-02	600	1500	38

GEN : = Number of generations
NPG : = Number of neutrons per generation
NSK : = Number of generations skipped prior to collecting data

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-004											
Case 1	26 51	981.67	0.54	1.0000	0.0047	1.0090	0.0015	5.34E-02	610	800	46
Case 2	26 50	971.63	0 54	1.0000	0.0047	1.0019	0.0013	5.37E-02	610	800	25
Case 3	27.65	929.60	0 54	1.0000	0.0047	1 0073	0.0015	5.48E-02	610	800	27
Case 4	28.57	884 12	0 54	1.0000	0.0047	1.0043	0.0013	5 60E-02	610	800	56
Case 5	27.94	925.52	1.76	1.0000	0.0047	1.0025	0.0013	5 46E-02	610	800	31
Case 6	28.78	898 58	3.12	1.0000	0.0047	1 0044	0.0015	5 49E-02	610	800	21
Case 7	29.88	864 01	3.12	1.0000	0.0047	1 0103	0.0015	5 59E-02	610	800	19
Case 8	30.33	841.98	3.12	1.0000	0.0047	1 0069	0.0013	5 65E-02	610	800	23
Case 9	31.79	780 21	3.12	1.0000	0.0047	1 0038	0.0014	5.87E-02	610	800	10
Case 10	35.68	667.98	3 12	1.0000	0.0047	1.0049	0.0016	6 32E-02	610	800	47
Case 11	39.62	573.34	3.12	1.0000	0.0047	1.0059	0.0013	6 85E-02	610	800	13
Case 12	29.74	865 01	3.12	1.0000	0.0047	1.0070	0.0014	5 59E-02	610	800	19
Case 13	29.63	872 21	3 43	1.0000	0.0047	1.0056	0.0012	5.56E-02	610	800	18
PU-SOL-THERM-005											
Case 1	29.94	866 36	4 05	1.0000	0.0047	1.0062	0.0015	5 56E-02	610	800	13
Case 2	30.77	832.71	4 05	1 0000	0.0047	1.0070	0.0014	5.66E-02	610	800	21
Case 3	31.72	800.71	4 05	1.0000	0.0047	1.0092	0.0012	5.77E-02	610	800	17
Case 4	33.94	734 37	4.05	1 0000	0 0047	1.0097	0 0014	6 01E-02	610	800	13
Case 5	36.38	666 08	4 05	1.0000	0 0047	1.0114	0 0013	6 30E-02	610	800	21
Case 6	38.72	607.89	4.05	1.0000	0.0047	1.0099	0.0015	6 61E-02	610	800	17
Case 7	41.16	557.17	4.05	1.0000	0 0047	1.0066	0 0012	6 93E-02	610	800	55
Case 8	30 92	830 64	4.40	1.0000	0 0047	1.0037	0 0013	5 66E-02	610	800	19
Case 9	32 41	788 95	4.40	1.0000	0 0047	1.0044	0 0013	5 80E-02	610	800	11
PU-SOL-THERM-006											
Case 1	25 06	1028.16	3.12	1.0000	0 0035	1.0065	0 0008	5 24E-02	1500	1000	49
Case 2	25 83	986.18	3.12	1.0000	0 0035	1.0077	0 0008	5 34E-02	1500	1000	18
Case 3	27 05	910 90	3.12	1 0000	0 0035	1.0081	0 0008	5 52E-02	1500	1000	25

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-008											
Case 1	35 5	683.88	4 67	1.0000	0 0033	1.0140	0 0010	6.48E-02	810	800	13
Case 2	45 2	495.93	4 67	1 0000	0 0040	1 0151	0 0012	7.85E-02	810	800	10
Case 3	46 4	488 55	4 67	1.0000	0.0040	1.0233	0.0010	7.94E-02	810	800	20
Case 4	46.9	486 15	4 67	1.0000	0.0040	1.0248	0.0011	8 02E-02	810	800	16
Case 5	32 8	782.40	4 67	1.0000	0.0028	1.0268	0.0012	6 03E-02	810	800	85
Case 7	29.6	867.10	4 67	1.0000	0.0028	1.0232	0.0012	5.71E-02	810	800	86
Case 8	50.9	454 50	4 67	1.0000	0.0040	1.0007	0.0012	8.73E-02	810	800	15
Case 9	232	85.03	4 67	1.0000	0.0061	1 0060	0.0012	5 51E-01	810	800	28
Case 10	43.4	521.45	4 67	1.0000	0.0037	1.0320	0.0011	7.52E-02	810	800	48
Case 11	36.6	650 83	4 67	1 0000	0 0031	1.0268	0.0011	6 62E-02	810	800	16
Case 12	67.9	344 02	4 67	1.0000	0.0041	1 0226	0 0013	9 94E-02	810	800	31
Case 13	50 4	499.92	4.67	1.0000	0 0041	1 0281	0 0013	7.68E-02	810	800	13
Case 14	75 0	328 02	4.67	1.0000	0.0042	1 0067	0 0013	1.08E-01	810	800	65
Case 15	46 4	538.18	4.67	1.0000	0.0041	1.0167	0 0012	7.46E-02	810	800	25
Case 16	36 5	673 07	4.67	1.0000	0 0033	1.0198	0 0013	6 53E-02	810	800	22
Case 17	46 4	488.55	4.67	1.0000	0 0040	1.0177	0 0011	7.95E-02	810	800	67
Case 18	46 9	486.15	4.67	1.0000	0 0040	1.0248	0 0012	8 01E-02	810	800	35
Case 19	32.9	776 81	4.67	1.0000	0 0028	1.0228	0.0012	6 05E-02	810	800	23
Case 20	30 0	856.60	4 67	1.0000	0 0028	1.0204	0 0011	5.74E-02	810	800	10
Case 21	50 9	462.99	4 67	1.0000	0 0040	1.0026	0 0013	8 60E-02	810	800	10
Case 22	232	88.43	4 67	1 0000	0 0061	0 9976	0 0015	5.20E-01	810	800	93
Case 23	44 8	496.98	4.67	1.0000	0 0037	1 0241	0 0011	7.73E-02	810	800	62
Case 24	36 8	639 34	4 67	1.0000	0 0031	1 0183	0 0012	6.68E-02	810	800	21
Case 25	67.8	344 02	4.67	1.0000	0.0042	1.0210	0 0011	9.96E-02	810	800	10
Case 26	52 1	474 90	4 67	1.0000	0 0041	1.0194	0 0014	7.93E-02	810	800	29
Case 27	106	232.01	4 67	1.0000	0 0042	1.0128	0 0014	1.47E-01	810	800	15
Case 28	81.7	301.12	4 67	1.0000	0 0042	1 0071	0 0014	1.16E-01	810	800	57
Case 29	52 4	475 39	4 67	1 0000	0.0041	1.0213	0 0014	8 03E-02	810	800	141
Case 30	47 0	531 21	4 67	1 0000	0.0041	1 0172	0.0013	7.50E-02	810	800	46

PU-SOL-THERM-011											
Case 1-16	35 0	733.00	4.17	1.0000	0.0052	1.0138	0.0013	0 0636	1003	1000	16
Case 1-18	22.4	1157.29	4 20	1.0000	0.0052	0 9993	0.0010	0 0520	1003	1000	76
Case 2-16	36 2	705 45	4.17	1.0000	0.0052	1.0201	0.0010	0 0647	1003	1000	9
Case 2-18	23.3	1103.19	4.20	1.0000	0 0052	1.0051	0 0009	0 0529	1003	1000	14
Case 3-16	38.1	662.77	4.17	1.0000	0 0052	1.0215	0 0010	0 0670	1003	1000	74
Case 3-18	23.1	1109.78	4.20	1 0000	0.0052	1.0007	0 0010	0 0529	1003	1000	69
Case 4-16	38.2	653 42	4.17	1.0000	0 0052	1.0157	0 0009	0 0678	1003	1000	36
Case 4-18	23.8	1053.74	4 20	1 0000	0 0052	0.9990	0 0009	0 0541	1003	1000	6
Case 5-16	43.4	550 66	4 17	1.0000	0 0052	1.0098	0 0010	0 0755	1003	1000	18
Case 5-18	25 2	995.41	4 20	1 0000	0.0052	1.0089	0.0010	0.0556	1003	1000	61
Case 6-18	27.5	870.37	4.20	1.0000	0 0052	1.0056	0 0009	0.0593	1003	1000	3
Case 7-18	23 9	1056 43	4 20	1.0000	0 0052	1.0045	0 0009	0.0540	1003	1000	13

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. Uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-014											
Case 1	115.10	210.18	4 23	0.9980	0.0032	1 0070	0 0010	1.68E-01	600	1800	15
Case 2	115.10	210 18	4.23	0 9980	0 0032	1.0059	0 0011	1.67E-01	600	1800	21
Case 3	115.10	210 18	4 23	0.9980	0 0032	1 0071	0.0011	1.67E-01	600	1800	65
Case 4	115.10	210.18	4.23	0.9980	0 0032	1.0066	0.0010	1.67E-01	600	1800	37
Case 5	115.10	210.18	4.23	0.9980	0 0032	1.0070	0.0011	1.67E-01	600	1800	12
Case 6	115.10	210.18	4.23	0.9980	0.0032	1 0057	0 0011	1.67E-01	600	1800	11
Case 7	115 10	210 18	4.23	0 9980	0.0032	1.0079	0 0012	1.68E-01	600	1800	42
Case 8	115 10	210.18	4 23	0.9980	0 0032	1.0061	0 0011	1.67E-01	600	1800	26
Case 9	115.10	210 18	4 23	0.9980	0.0032	1.0060	0 0009	1.68E-01	600	1800	10
Case 10	115 10	210 18	4 23	0 9980	0.0032	1.0071	0.0011	1.67E-01	600	1800	49
Case 11	115.10	210 18	4.23	0.9980	0.0032	1.0062	0 0011	1.67E-01	600	1800	44
Case 12	115.10	210 18	4.23	0.9980	0.0032	1.0083	0 0009	1.66E-01	600	1800	12
Case 13	115 10	210 18	4 23	0.9980	0 0043	1.0078	0 0010	1.69E-01	600	1800	12
Case 14	115.10	210.18	4 23	0.9980	0.0043	1 0068	0.0010	1.68E-01	600	1800	26
Case 15	115.10	210.18	4 23	0.9980	0 0043	1 0061	0.0010	1.67E-01	600	1800	16
Case 16	115.10	210.18	4.23	0.9980	0 0043	1.0062	0.0010	1.66E-01	600	1800	29
Case 17	115.10	210.18	4.23	0.9980	0 0043	1.0067	0.0012	1.67E-01	600	1800	25
Case 18	115.10	210.18	4.23	0 9980	0 0043	1.0082	0 0009	1.68E-01	600	1800	55
Case 19	115.10	210.18	4.23	0 9980	0.0043	1.0067	0 0010	1 68E-01	600	1800	24
Case 20	115.10	210 18	4 23	0 9980	0 0043	1.0058	0 0010	1.67E-01	600	1800	29
Case 21	115 10	210 18	4 23	0 9980	0.0043	1.0053	0.0010	1.67E-01	600	1800	25
Case 22	115 10	210 18	4 23	0 9980	0.0043	1.0049	0 0011	1.67E-01	600	1800	60
Case 23	115.10	210 18	4.23	0 9980	0.0043	1.0056	0 0011	1.67E-01	600	1800	17
Case 24	115.10	210.18	4.23	0 9980	0 0043	1.0082	0 0012	1.68E-01	600	1800	17
Case 25	115 10	210 18	4 23	0.9980	0 0043	1.0042	0 0011	1.68E-01	600	1800	25
Case 26	115.10	210.18	4 23	0.9980	0 0043	1.0033	0.0011	1 67E-01	600	1800	40
Case 27	115.10	210.18	4.23	0.9980	0 0043	1.0057	0.0010	1 67E-01	600	1800	10
Case 28	115.10	210.18	4.23	0.9980	0 0043	1.0056	0.0010	1.67E-01	600	1800	27
Case 29	115.10	210.18	4 23	0 9980	0 0043	1.0062	0 0012	1.67E-01	600	1800	22
Case 30	115 10	210 18	4 23	0.9980	0 0043	1.0057	0 0010	1.69E-01	1300	1000	16
Case 31	115.10	210 18	4 23	0 9980	0 0043	1.0027	0 0010	1.68E-01	1300	1000	30
Case 32	115 10	210 18	4 23	0 9980	0.0043	1.0048	0 0010	1.68E-01	1300	1000	40
Case 33	115 10	210.18	4 23	0.9980	0.0043	1.0036	0 0011	1 68E-01	1300	1000	23
Case 34	115.10	210 18	4.23	0 9980	0.0043	1.0043	0 0009	1 67E-01	1300	1000	40
Case 35	115.10	210.18	4.23	0.9980	0 0043	1 0042	0 0010	1 67E-01	1303	1000	15

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-015											
Case 1	152 50	155.21	4.23	0 9980	0 0038	1.0099	0 0010	2.37E-01	600	1800	18
Case 2	152 50	155 27	4.23	0 9980	0 0038	1 0087	0.0010	2.37E-01	600	1800	17
Case 3	152 50	155 27	4.23	0.9980	0 0038	1.0076	0.0010	2.36E-01	600	1800	10
Case 4	152.50	155.27	4.23	0.9980	0.0038	1.0070	0 0012	2.36E-01	600	1800	23
Case 5	152 50	155 27	4.23	0 9980	0 0038	1 0077	0 0010	2.36E-01	600	1800	19
Case 6	152.50	155 27	4.23	0.9980	0 0038	1.0062	0 0011	2.36E-01	600	1800	18
Case 7	152.50	155 27	4.23	0.9971	0.0047	1.0097	0 0010	2.38E-01	600	1800	16
Case 8	152.50	155 27	4.23	0.9971	0.0047	1.0044	0 0011	2.38E-01	600	1800	10
Case 9	152 50	155 27	4 23	0 9971	0.0047	1.0078	0.0010	2.36E-01	600	1800	13
Case 10	152.50	155 27	4 23	0.9971	0.0047	1.0069	0 0011	2.36E-01	600	1800	128
Case 11	152.50	155.27	4 23	0.9971	0.0047	1.0034	0 0012	2.38E-01	600	1800	11
Case 12	152.50	155 27	4 23	0.9971	0.0047	1.0018	0 0011	2.38E-01	600	1800	21
Case 13	152.50	155 27	4 23	0.9971	0.0047	1.0062	0 0010	2.37E-01	600	1800	11
Case 14	152.50	155 27	4 23	0.9971	0.0047	1.0079	0 0011	2.35E-01	600	1800	49
Case 15	152 50	155 27	4 23	0.9971	0.0047	1.0078	0 0010	2.38E-01	600	1800	22
Case 16	152.50	155 27	4 23	0 9971	0.0047	1.0056	0 0011	2.38E-01	600	1800	35
Case 17	152.50	155.27	4 23	0 9971	0.0047	1.0062	0 0013	2 37E-01	600	1800	18
PU-SOL-THERM-016											
Case 1	152 50	155 27	4 23	0 9980	0.0043	1.0054	0 0011	2 38E-01	1000	1000	11
Case 2	152.50	155.27	4 23	0 9980	0 0043	1.0077	0 0010	2.37E-01	1000	1000	10
Case 3	152.50	155.27	4 23	0 9980	0 0043	1.0073	0 0012	2.36E-01	1000	1000	17
Case 4	152.50	155 27	4 23	0 9980	0 0043	1.0077	0 0011	2 37E-01	1000	1000	75
Case 5	115.10	210 18	4.23	0 9969	0 0038	1.0056	0 0012	1.68E-01	1000	1000	23
Case 6	115.10	210 17	4 23	0 9969	0 0038	1.0056	0.0012	1.67E-01	1000	1000	18
Case 7	115.10	210 17	4 23	0 9969	0 0038	1.0078	0 0011	1 67E-01	1000	1000	41
Case 8	115.10	210 17	4 23	0 9969	0 0038	1.0072	0 0010	1.67E-01	1000	1000	10
Case 9	115.10	210 17	4 23	0.9963	0 0033	1.0055	0 0012	1.65E-01	1000	1000	68
Case 10	115.10	210 17	4 23	0.9963	0 0033	1 0056	0 0012	1.66E-01	1000	1000	32
Case 11	115.10	210 17	4 23	0.9963	0 0033	1 0064	0 0012	1 67E-01	1000	1000	33

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-017											
Case 1	115 10	210.18	4.23	0 9969	0 0038	1.0052	0 0011	1.67E-01	1000	1000	14
Case 2	115 10	210 18	4.23	0 9969	0.0038	1.0063	0 0012	1.67E-01	1000	1000	11
Case 3	115.10	210.18	4.23	0 9969	0.0038	1.0045	0 0012	1.67E-01	1000	1000	21
Case 4	115.10	210 18	4.23	0 9969	0.0038	1.0058	0 0011	1.67E-01	1000	1000	10
Case 5	115.10	210.18	4.23	0 9969	0.0038	1.0058	0.0010	1.67E-01	1000	1000	47
Case 6	115.10	210.18	4 23	0 9969	0.0038	1.0051	0.0011	1.67E-01	1000	1000	27
Case 7	115.10	210.18	4.23	0.9969	0.0038	1.0057	0 0012	1.67E-01	1000	1000	43
Case 8	115.10	210 18	4 23	0.9969	0 0038	1.0072	0 0011	1.67E-01	1000	1000	31
Case 9	115.10	210 18	4 23	0.9969	0 0038	1.0065	0.0011	1.67E-01	1000	1000	13
Case 10	115.10	210 18	4 23	0.9969	0.0038	1.0077	0.0013	1 67E-01	1000	1000	17
Case 11	115.10	210 18	4 23	0.9969	0 0038	1.0045	0.0010	1.67E-01	1000	1000	11
Case 12	115.10	210 18	4 23	0.9969	0 0038	1.0064	0.0011	1.67E-01	1000	1000	22
Case 13	115.10	210 18	4 23	0.9969	0 0038	1.0052	0.0011	1.67E-01	1000	1000	35
Case 14	115.10	210.18	4 23	0.9969	0 0038	1.0087	0.0012	1.67E-01	1000	1000	17
Case 15	115.10	210.18	4 23	0 9969	0 0038	·1.0054	0 0012	1.67E-01	1000	1000	33
Case 16	115.10	210 18	4 23	0.9969	0 0038	1.0081	0.0011	1.67E-01	1000	1000	20
Case 17	115.10	210 18	4 23	0 9969	0 0038	1 0037	0 0011	1.67E-01	1000	1000	34
Case 18	115.10	210.18	4 23	0.9969	0 0038	1.0053	0 0011	1.67E-01	1000	1000	104

PU-SOL-THERM-020											
Case 1	39.20	603.57	4 67	1 0000	0.0059	1.0088	0 0012	6.57E-02	610	800	15
Case 2	38 40	621.12	4 67	1.0000	0.0059	1.0113	0 0015	6.47E-02	610	800	13
Case 3	33.50	747.18	4.67	1 0000	0.0059	1.0059	0 0012	5.89E-02	610	800	10
Case 5	47.90	462.51	4.67	1.0000	0.0059	1 0060	0 0014	7.63E-02	610	800	11
Case 6	49.50	451.85	4.67	1.0000	0.0059	1.0063	0 0013	7.93E-02	610	800	15
Case 7	34 40	723 85	4.67	1.0000	0.0059	1.0021	0 0013	6 04E-02	610	800	12
Case 8	69.40	342 96	4 67	1 0000	0.0059	1.0096	0 0014	1.06E-01	610	800	76
Case 9	46 90	540 11	4.67	1.0000	0 0059	1.0024	0 0013	7.58E-02	610	800	12
Case 10	38 60	617 24	4.67	1.0000	0 0059	1.0100	0 0015	6 48E-02	610	800	10
Case 11	33 20	753 99	4 67	1.0000	0 0059	1.0078	0 0012	5.85E-02	610	800	10
Case 12	47.50	465 80	4 67	1.0000	0 0059	1.0065	0.0014	7.59E-02	610	800	55
Case 13	49 50	451.85	4.67	1.0000	0 0059	1.0055	0.0013	7.92E-02	610	800	29
Case 14	46.90	540 11	4 67	1.0000	0 0059	1 0005	0.0014	7 60E-02	610	800	11
Case 15	69.00	341.17	4.67	1.0000	0 0059	1.0004	0.0015	1 07E-01	610	800	11

(Sun calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF	GEN	NPG	NSK
PU-SOL-THERM-025											
Case 1	58	424.34	4.671	1.0000	0 0039	1.0150	0.0004	7.87E-02	1503	1000	107
Case 2	58	424.34	4.671	1.0000	0 0039	1.0155	0.0004	7.88E-02	1503	1000	11
Case 3	58	424.34	4 671	1.0000	0 0039	1.0160	0.0004	7.91E-02	1503	1000	40
Case 4	58	424.34	4.671	1.0000	0 0039	1.0161	0.0005	7.97E-02	1503	1000	21
Case 5	58	424.34	4.671	1.0000	0 0039	1.0121	0 0004	8 02E-02	1503	1000	39
Case 6	58	424 34	4.671	1.0000	0 0039	1 0097	0 0004	8 05E-02	1503	1000	75
PU-SOL-THERM-026											
Case 1	57.3	430 26	4.67	1.0000	0 0052	0 9996	0 0005	8 82E-02	1503	1000	56
Case 2	57.7	425.56	4.67	1.0000	0 0052	0 9974	0 0005	8 89E-02	1503	1000	123
Case 3	57.7	425 27	4 67	1 0000	0.0051	0 9968	0 0004	8 90E-02	1503	1000	50

ATTACHMENT NUMBER 1B

AOA(1) CRITICALITY RESULTS ON PC PLATFORM

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-001											
Case 1	73.00	352 91	4.67	1.0000	0 005	1 0091	0 0012	8 80E-02	1503	1000	7
Case 2	96.00	258 05	4 67	1.0000	0 005	1.0097	0.0008	1.11E-01	1503	1000	23
Case 3	119.00	205.14	4.67	1.0000	0 005	1.0115	0.0008	1.35E-01	1503	1000	17
Case 4	132.00	180 97	4 67	1.0000	0.005	1.0059	0.0008	1.51E-01	1503	1000	48
Case 5	140.00	171.21	4.67	1.0000	0 005	1 0092	0.0008	1.60E-01	1503	1000	42
Case 6	268.70	86.66	4 67	1.0000	0.005	1.0087	0.0008	3 47E-01	1503	1000	61
PU-SOL-THERM-002											
Case 1	50.32	507.98	3.12	1 0000	0 0047	1 0077	0 0008	7.12E-02	1503	1000	19
Case 2	51.80	489.18	3 12	1.0000	0 0047	1.0077	0 0008	7.29E-02	1503	1000	26
Case 3	56.48	437.28	3.12	1.0000	0 0047	1.0083	0 0007	7.79E-02	1503	1000	17
Case 4	60.14	407.45	3 12	1.0000	0 0047	1.0100	0 0009	8.14E-02	1503	1000	6
Case 5	63.96	380.57	3.12	1.0000	0 0047	1 0115	0 0008	8 51E-02	1503	1000	39
Case 6	70 22	333.54	3.12	1.0000	0.0047	1.0082	0 0008	9.29E-02	1503	1000	25
Case 7	77.22	299 26	3.12	1.0000	0.0047	1.0103	0.0008	1.00E-01	1503	1000	10
PU-SOL-THERM-003											
Case 1	33.62	774.15	1.76	1.0000	0.0047	1.0062	0 0008	5 84E-02	1503	1000	9
Case 2	34.70	742.71	1.76	1.0000	0.0047	1.0068	0 0008	5.96E-02	1503	1000	13
Case 3	38 05	677.17	3 12	1.0000	0.0047	1.0078	0 0008	6.19E-02	1503	1000	8
Case 4	38 83	660.55	3.12	1 0000	0.0047	1.0092	0 0007	6.27E-02	1503	1000	11
Case 5	40.90	607.17	3 12	1.0000	0.0047	1.0100	0 0008	6.54E-02	1503	1000	14
Case 6	44 38	545.33	3.12	1.0000	0.0047	1.0099	0 0009	6.94E-02	1503	1000	44
Case 7	36 27	714.83	3 12	1.0000	0.0047	1.0106	0 0008	5.92E-02	1503	1000	7
Case 8	37.11	692.12	3.12	1.0000	0.0047	1.0100	0.0007	6.01E-02	1503	1000	20

GEN : = Number of generations
NPG : = Number of neutrons per generation
NSK : = Number of generations skipped prior to collecting data

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-004											
Case 1	26.51	981.67	0 54	1.0000	0 0047	1.0063	0 0008	5 34E-02	1503	1000	209
Case 2	26.50	971.63	0 54	1.0000	0 0047	1 0036	0 0007	5 37E-02	1503	1000	21
Case 3	27.65	929.60	0 54	1.0000	0 0047	1 0061	0 0007	5.47E-02	1503	1000	4
Case 4	28.57	884.12	0 54	1.0000	0 0047	1.0038	0.0007	5.60E-02	1503	1000	25
Case 5	27.94	925 52	1.76	1 0000	0 0047	1.0045	0 0007	5.45E-02	1503	1000	24
Case 6	28.78	898 58	3 12	1.0000	0 0047	1 0065	0 0008	5 49E-02	1503	1000	14
Case 7	29.88	864 01	3 12	1.0000	0 0047	1 0108	0 0008	5 58E-02	1503	1000	47
Case 8	30 33	841.98	3 12	1.0000	0 0047	1 0070	0 0007	5.65E-02	1503	1000	21
Case 9	31.79	780 21	3 12	1.0000	0 0047	1.0046	0 0007	5 86E-02	1503	1000	4
Case 10	35.68	667.98	3.12	1.0000	0.0047	1.0066	0 0008	6.32E-02	1503	1000	8
Case 11	39.62	573.34	3.12	1.0000	0 0047	1.0040	0.0007	6 86E-02	1503	1000	3
Case 12	29 74	865.01	3 12	1.0000	0 0047	1.0077	0 0007	5 59E-02	1503	1000	10
Case 13	29.63	872.21	3 43	1.0000	0.0047	1.0059	0 0007	5.56E-02	1503	1000	3
PU-SOL-THERM-005											
Case 1	29.94	866.36	4 05	1 0000	0.0047	1.0085	0 0007	5.55E-02	1503	1000	4
Case 2	30.77	832.71	4 05	1.0000	0.0047	1.0074	0 0007	5 66E-02	1503	1000	12
Case 3	31.72	800 71	4.05	1.0000	0.0047	1.0078	0 0008	5.76E-02	1503	1000	39
Case 4	33.94	734.37	4 05	1.0000	0.0047	1.0106	0 0008	6 00E-02	1503	1000	8
Case 5	36 38	666 08	4 05	1.0000	0.0047	1.0101	0 0007	6 29E-02	1503	1000	5
Case 6	38.72	607.89	4 05	1.0000	0.0047	1.0104	0 0007	6 60E-02	1503	1000	7
Case 7	41.16	557.17	4 05	1.0000	0.0047	1.0083	0 0009	6 92E-02	1503	1000	16
Case 8	30 92	830 64	4 40	1.0000	0.0047	1.0051	0 0007	5 67E-02	1503	1000	18
Case 9	32 41	788 95	4 40	1.0000	0.0047	1.0070	0 0007	5.79E-02	1503	1000	38
PU-SOL-THERM-006											
Case 1	25.06	1028.16	3.12	1.0000	0.0035	1.0050	0 0008	5.25E-02	1503	1000	10
Case 2	25.83	986 18	3 12	1.0000	0.0035	1.0062	0 0007	5.33E-02	1503	1000	30
Case 3	27.05	910 90	3 12	1.0000	0.0035	1.0063	0 0007	5.52E-02	1503	1000	3

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-008											
Case 1	35.5	683 88	4.67	1.0000	0.0033	1.0137	0 0008	6 49E-02	1503	1000	17
Case 2	45.2	495 93	4 67	1.0000	0.0040	1.0159	0 0008	7.84E-02	1503	1000	14
Case 3	46.4	488 55	4.67	1.0000	0 0040	1.0227	0 0008	7.95E-02	1503	1000	28
Case 4	46.9	486 15	4 67	1.0000	0 0040	1.0274	0.0007	8 01E-02	1503	1000	14
Case 5	32.8	782 40	4 67	1.0000	0 0028	1.0282	0.0007	6 02E-02	1503	1000	58
Case 7	29.6	867.10	4 67	1.0000	0 0028	1.0220	0.0007	5.72E-02	1503	1000	24
Case 8	50 9	454.50	4 67	1.0000	0 0040	1 0014	0.0008	8.73E-02	1503	1000	18
Case 9	232	85 03	4.67	1.0000	0 0061	1.0071	0.0008	5 49E-01	1503	1000	24
Case 10	43 4	521.45	4 67	1.0000	0 0037	1.0317	0.0007	7.52E-02	1503	1000	6
Case 11	36 6	650.83	4 67	1.0000	0 0031	1.0264	0 0007	6.62E-02	1503	1000	18
Case 12	67.9	344.02	4 67	1.0000	0.0041	1.0219	0 0009	9.97E-02	1503	1000	5
Case 13	50 4	499.92	4 67	1.0000	0 0041	1.0275	0 0008	7.67E-02	1503	1000	29
Case 14	75.0	328 02	4 67	1.0000	0 0042	1 0074	0 0008	1.07E-01	1503	1000	4
Case 15	46 4	538.18	4.67	1.0000	0.0041	1.0172	0 0008	7.44E-02	1503	1000	3
Case 16	36 5	673.07	4.67	1.0000	0.0033	1 0207	0 0008	6 53E-02	1503	1000	65
Case 17	46 4	488 55	4.67	1.0000	0.0040	1.0176	0 0008	7.95E-02	1503	1000	3
Case 18	46 9	486.15	4.67	1.0000	0.0040	1.0247	0 0007	8.02E-02	1503	1000	7
Case 19	32 9	776 81	4.67	1.0000	0.0028	1.0200	0 0007	6 05E-02	1503	1000	38
Case 20	30 0	856 60	4.67	1.0000	0.0028	1.0195	0 0008	5.75E-02	1503	1000	31
Case 21	50.9	462 99	4.67	1 0000	0.0040	1.0022	0 0008	8.60E-02	1503	1000	10
Case 22	232	88.43	4 67	1 0000	0.0061	0.9948	0 0008	5 20E-01	1503	1000	10
Case 23	44.8	496 98	4 67	1.0000	0 0037	1 0246	0.0008	7 72E-02	1503	1000	12
Case 24	36.8	639 34	4.67	1.0000	0 0031	1.0187	0.0007	6.68E-02	1503	1000	12
Case 25	67.8	344 02	4 67	1.0000	0 0042	1.0208	0.0008	9.94E-02	1503	1000	3
Case 26	52.1	474.90	4 67	1.0000	0 0041	1.0204	0.0008	7.92E-02	1503	1000	81
Case 27	106	232 01	4 67	1.0000	0 0042	1.0129	0.0009	1.47E-01	1503	1000	16
Case 28	81.7	301.12	4 67	1.0000	0 0042	1 0062	0.0008	1.15E-01	1503	1000	3
Case 29	52.4	475 39	4.67	1 0000	0 0041	1 0208	0.0009	8 03E-02	1503	1000	6
Case 30	47.0	531.21	4 67	1.0000	0 0041	1.0180	0.0008	7.50E-02	1503	1000	3

PU-SOL-THERM-011											
Case 1-16	35.0	733.00	4.17	1.0000	0 0052	1.0155	0 0008	6.34E-02	1503	1000	21
Case 1-18	22.4	1157.29	4.2	1 0000	0.0052	0 9998	0 0007	5.20E-02	1503	1000	12
Case 2-16	36 2	705.45	4.17	1.0000	0.0052	1.0209	0 0008	6.47E-02	1503	1000	49
Case 2-18	23 3	1103 19	4 2	1.0000	0.0052	1.0055	0 0008	5 30E-02	1503	1000	102
Case 3-16	38.1	662.77	4.17	1.0000	0.0052	1.0207	0 0008	6 72E-02	1503	1000	13
Case 3-18	23.1	1109 78	4 2	1 0000	0.0052	1.0023	0 0007	5 29E-02	1503	1000	7
Case 4-16	38 2	653 42	4 17	1 0000	0.0052	1.0132	0 0009	6 79E-02	1503	1000	93
Case 4-18	23 8	1053.74	4 2	1.0000	0 0052	0 9994	0 0008	5 41E-02	1503	1000	5
Case 5-16	43.4	550 66	4 17	1.0000	0 0052	1.0102	0 0008	7 54E-02	1503	1000	11
Case 5-18	25.2	995 41	4 2	1.0000	0 0052	1.0105	0.0008	5 56E-02	1503	1000	36
Case 6-18	27.5	870 37	4.2	1.0000	0.0052	1.0064	0.0008	5 93E-02	1503	1000	3
Case 7-18	23.9	1056 43	4.2	1.0000	0.0052	1.0063	0.0008	5 40E-02	1503	1000	32

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-014											
Case 1	115.10	210 18	4 23	0.9980	0.0032	1.0071	0.0008	1.68E-01	1503	1000	31
Case 2	115.10	210 18	4 23	0.9980	0 0032	1.0059	0.0009	1 67E-01	1503	1000	28
Case 3	115.10	210 18	4 23	0.9980	0 0032	1 0080	0.0009	1 67E-01	1503	1000	11
Case 4	115.10	210 18	4.23	0.9980	0 0032	1.0060	0.0008	1.67E-01	1503	1000	22
Case 5	115.10	210 18	4 23	0.9980	0 0032	1 0074	0.0009	1 67E-01	1503	1000	35
Case 6	115.10	210 18	4 23	0.9980	0 0032	1 0060	0.0009	1.67E-01	1503	1000	4
Case 7	115.10	210 18	4.23	0 9980	0 0032	1.0059	0.0009	1.68E-01	1503	1000	29
Case 8	115.10	210 18	4 23	0 9980	0 0032	1 0055	0.0008	1.68E-01	1503	1000	23
Case 9	115.10	210 18	4 23	0.9980	0 0032	1 0052	0.0008	1 67E-01	1503	1000	9
Case 10	115.10	210.18	4 23	0.9980	0 0032	1.0038	0.0009	1.67E-01	1503	1000	9
Case 11	115.10	210.18	4 23	0.9980	0 0032	1.0053	0 0008	1.67E-01	1503	1000	7
Case 12	115.10	210 18	4 23	0.9980	0 0032	1.0070	0 0009	1.67E-01	1503	1000	58
Case 13	115.10	210.18	4 23	0 9980	0.0043	1.0077	0 0008	1.68E-01	1503	1000	3
Case 14	115.10	210.18	4.23	0 9980	0 0043	1.0043	0.0009	1.68E-01	1503	1000	99
Case 15	115.10	210.18	4 23	0 9980	0.0043	1.0070	0 0008	1.67E-01	1503	1000	10
Case 16	115.10	210.18	4 23	0 9980	0.0043	1.0057	0 0009	1.67E-01	1503	1000	7
Case 17	115.10	210 18	4.23	0 9980	0.0043	1.0055	0.0009	1.67E-01	1503	1000	5
Case 18	115 10	210 18	4.23	0.9980	0.0043	1.0080	0 0009	1.68E-01	1503	1000	7
Case 19	115.10	210.18	4.23	0 9980	0.0043	1.0049	0 0010	1.68E-01	1503	1000	9
Case 20	115.10	210.18	4.23	0.9980	0.0043	1.0068	0 0009	1.67E-01	1503	1000	114
Case 21	115 10	210 18	4.23	0 9980	0 0043	1.0063	0 0008	1.67E-01	1503	1000	22
Case 22	115.10	210 18	4 23	0.9980	0 0043	1.0060	0.0009	1.67E-01	1503	1000	4
Case 23	115.10	210 18	4 23	0.9980	0.0043	1.0053	0.0009	1.67E-01	1503	1000	28
Case 24	115.10	210 18	4.23	0.9980	0 0043	1.0082	0.0008	1.69E-01	1503	1000	36
Case 25	115.10	210 18	4 23	0.9980	0 0043	1.0042	0.0009	1.68E-01	1503	1000	65
Case 26	115.10	210.18	4 23	0.9980	0.0043	1.0068	0.0009	1.67E-01	1503	1000	20
Case 27	115.10	210.18	4 23	0.9980	0 0043	1.0059	0.0009	1.67E-01	1503	1000	70
Case 28	115.10	210 18	4 23	0 9980	0 0043	1.0053	0 0009	1.67E-01	1503	1000	15
Case 29	115.10	210 18	4.23	0 9980	0 0043	1.0057	0 0009	1.67E-01	1503	1000	5
Case 30	115.10	210 18	4 23	0 9980	0 0043	1.0051	0 0008	1.68E-01	1503	1000	32
Case 31	115 10	210.18	4 23	0 9980	0 0043	1.0039	0.0009	1.68E-01	1503	1000	5
Case 32	115.10	210.18	4.23	0 9980	0 0043	1.0045	0 0009	1.68E-01	1503	1000	23
Case 33	115.10	210.18	4.23	0 9980	0 0043	1.0063	0.0008	1.67E-01	1503	1000	10
Case 34	115.10	210.18	4 23	0 9980	0.0043	1.0043	0 0010	1.68E-01	1503	1000	44
Case 35	115 10	210.18	4.23	0 9980	0.0043	1.0050	0 0010	1.67E-01	1503	1000	12

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-015											
Case 1	152 50	155.21	4.23	0 9980	0 0038	1.0073	0.0009	2.38E-01	1503	1000	61
Case 2	152 50	155.27	4 23	0.9980	0 0038	1.0080	0 0008	2.37E-01	1503	1000	5
Case 3	152 50	155.27	4 23	0.9980	0 0038	1.0059	0 0009	2.37E-01	1503	1000	3
Case 4	152 50	155.27	4 23	0.9980	0 0038	1.0063	0 0009	2.37E-01	1503	1000	38
Case 5	152.50	155.27	4 23	0 9980	0.0038	1.0047	0.0009	2.37E-01	1503	1000	231
Case 6	152.50	155.27	4 23	0 9980	0.0038	1.0073	0.0008	2.36E-01	1503	1000	40
Case 7	152.50	155.27	4 23	0 9971	0.0047	1.0075	0 0009	2.38E-01	1503	1000	71
Case 8	152.50	155.27	4.23	0.9971	0.0047	1.0070	0.0009	2.37E-01	1503	1000	19
Case 9	152 50	155.27	4 23	0.9971	0.0047	1.0068	0 0008	2.37E-01	1503	1000	15
Case 10	152 50	155.27	4 23	0.9971	0.0047	1.0055	0 0009	2.36E-01	1503	1000	6
Case 11	152.50	155.27	4.23	0.9971	0.0047	1.0040	0.0009	2 38E-01	1503	1000	150
Case 12	152.50	155.27	4 23	0.9971	0.0047	1.0036	0.0008	2 38E-01	1503	1000	4
Case 13	152.50	155 27	4 23	0.9971	0.0047	1.0060	0.0009	2 37E-01	1503	1000	6
Case 14	152.50	155 27	4 23	0.9971	0.0047	1.0067	0.0009	2.36E-01	1503	1000	19
Case 15	152.50	155.27	4.23	0.9971	0.0047	1.0071	0.0008	2 39E-01	1503	1000	22
Case 16	152.50	155.27	4.23	0.9971	0 0047	1.0053	0.0009	2 38E-01	1503	1000	53
Case 17	152.50	155.27	4.23	0 9971	0 0047	1.0062	0 0009	2.37E-01	1503	1000	4
PU-SOL-THERM-016											
Case 1	152 50	155.27	4 23	0 9980	0.0043	1.0061	0.0009	2.37E-01	1503	1000	3
Case 2	152.50	155.27	4.23	0 9980	0 0043	1.0053	0.0009	2.37E-01	1503	1000	14
Case 3	152 50	155 27	4.23	0 9980	0 0043	1 0071	0 0009	2.37E-01	1503	1000	10
Case 4	152 50	155 27	4.23	0.9980	0 0043	1.0068	0 0009	2.36E-01	1503	1000	16
Case 5	115 10	210.18	4.23	0.9969	0 0038	1.0043	0 0009	1.68E-01	1503	1000	11
Case 6	115 10	210.17	4.23	0 9969	0 0038	1.0044	0 0009	1.67E-01	1503	1000	6
Case 7	115 10	210.17	4 23	0 9969	0 0038	1.0070	0 0009	1.67E-01	1503	1000	13
Case 8	115 10	210.17	4 23	0.9969	0 0038	1.0077	0 0009	1.67E-01	1503	1000	35
Case 9	115.10	210.17	4.23	0.9963	0 0033	1.0059	0.0009	1.66E-01	1503	1000	34
Case 10	115.10	210.17	4 23	0.9963	0 0033	1.0050	0 0010	1.66E-01	1503	1000	6
Case 11	115.10	210 17	4 23	0.9963	0 0033	1.0064	0 0009	1.67E-01	1503	1000	10

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-017											
Case 1	115.10	210 18	4 23	0.9969	0.0038	1.0042	0.0009	1.67E-01	1503	1000	72
Case 2	115.10	210 18	4.23	0.9969	0.0038	1.0057	0.0009	1.67E-01	1503	1000	12
Case 3	115.10	210.18	4.23	0.9969	0.0038	1.0052	0.0009	1.67E-01	1503	1000	27
Case 4	115 10	210 18	4.23	0.9969	0 0038	1.0049	0 0008	1.67E-01	1503	1000	20
Case 5	115.10	210 18	4 23	0.9969	0 0038	1.0062	0 0009	1.67E-01	1503	1000	15
Case 6	115 10	210 18	4.23	0.9969	0 0038	1.0056	0 0009	1.67E-01	1503	1000	8
Case 7	115.10	210 18	4.23	0 9969	0 0038	1.0038	0 0010	1.67E-01	1503	1000	86
Case 8	115.10	210.18	4 23	0 9969	0 0038	1.0052	0 0010	1.67E-01	1503	1000	25
Case 9	115 10	210.18	4.23	0.9969	0 0038	1.0059	0.0010	1.67E-01	1503	1000	17
Case 10	115.10	210.18	4 23	0 9969	0 0038	1.0047	0 0009	1.68E-01	1503	1000	20
Case 11	115.10	210.18	4 23	0.9969	0 0038	1.0058	0 0009	1.67E-01	1503	1000	36
Case 12	115 10	210.18	4 23	0 9969	0.0038	1.0056	0 0010	1.67E-01	1503	1000	25
Case 13	115.10	210.18	4 23	0.9969	0 0038	1.0060	0 0009	1.67E-01	1503	1000	17
Case 14	115.10	210.18	4 23	0 9969	0.0038	1.0061	0 0009	1.67E-01	1503	1000	71
Case 15	115.10	210.18	4 23	0 9969	0 0038	1.0071	0.0008	1.67E-01	1503	1000	61
Case 16	115.10	210.18	4 23	0.9969	0 0038	1.0070	0.0009	1.67E-01	1503	1000	52
Case 17	115 10	210.18	4.23	0 9969	0 0038	1.0057	0 0009	1 67E-01	1503	1000	39
Case 18	115 10	210.18	4.23	0.9969	0 0038	1.0064	0 0009	1 67E-01	1503	1000	14

PU-SOL-THERM-020											
Case 1	39.20	603 57	4.67	1.0000	0 0059	1.0080	0 0008	6 56E-02	1503	1000	21
Case 2	38.40	621 12	4 67	1 0000	0 0059	1.0104	0 0007	6 47E-02	1503	1000	4
Case 3	33.50	747.18	4.67	1.0000	0.0059	1.0054	0 0008	5 89E-02	1503	1000	15
Case 5	47.90	462 51	4 67	1.0000	0.0059	1.0087	0.0007	7 62E-02	1503	1000	22
Case 6	49.50	451.85	4 67	1.0000	0 0059	1.0073	0 0007	7 92E-02	1503	1000	6
Case 7	34 40	723 85	4 67	1 0000	0 0059	1.0022	0 0008	6 03E-02	1503	1000	32
Case 8	69.40	342 96	4 67	1.0000	0 0059	1.0069	0 0009	1 06E-01	1503	1000	52
Case 9	46 90	540.11	4 67	1.0000	0 0059	0 9989	0 0008	7 60E-02	1503	1000	40
Case 10	38 60	617.24	4 67	1.0000	0.0059	1.0088	0.0008	6 49E-02	1503	1000	3
Case 11	33.20	753 99	4 67	1.0000	0.0059	1.0058	0.0008	5 87E-02	1503	1000	21
Case 12	47.50	465 80	4 67	1.0000	0.0059	1.0072	0.0008	7 60E-02	1503	1000	13
Case 13	49 50	451 85	4 67	1.0000	0.0059	1.0087	0.0008	7.92E-02	1503	1000	18
Case 14	46 90	540.11	4 67	1.0000	0.0059	1.0002	0.0009	7.60E-02	1503	1000	6
Case 15	69 00	341.17	4.67	1.0000	0.0059	1.0017	0.0008	1 06E-01	1503	1000	7

(PC calculation results)

Experiment	C(Pu) [g/l]	H/Pu	^{240}Pu [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
PU-SOL-THERM-025											
Case 1	58	424 34	4 671	1.0000	0.0039	1.0149	0 0004	7.87E-02	1503	1000	87
Case 2	58	424 34	4 671	1.0000	0.0039	1.0159	0 0005	7.88E-02	1503	1000	11
Case 4	58	424 34	4 671	1.0000	0.0039	1.0158	0 0005	7.91E-02	1503	1000	38
Case 5	58	424 34	4 671	1.0000	0.0039	1.015	0 0004	7.97E-02	1503	1000	16
Case 5	58	424 34	4 671	1.0000	0.0039	1.0125	0 0004	8.02E-02	1503	1000	55
Case 6	58	424 34	4 671	1.0000	0.0039	1.0089	0 0004	8.06E-02	1503	1000	16
PU-SOL-THERM-026											
Case 1	57.3	430 26	4 67	1.0000	0.0052	0 9971	0.0005	8.82E-02	1503	1000	52
Case 2	57.7	425.56	4 67	1.0000	0 0052	0 9965	0 0004	8.89E-02	1503	1000	52
Case 3	57.7	425 27	4 67	1.0000	0 0051	0 9971	0 0005	8.90E-02	1503	1000	58

ATTACHMENT NUMBER 2

CRITICAL EXPERIMENTS FOR AOA(2)

ICSBEP MOX Fuel Rod Lattices Benchmarks

The ICSBEP Handbook [6] includes a number of experiments related to the MOX fuel area of applicability. However, some of these experiments were determined to be inapplicable to MFFF design applications within AOA(1). The list below provides the reasoning for inclusion or exclusion of each candidate experiment.

MIX-COMP-THERM-001: This benchmark is not selected because the Pu content is not in range (Pu content = 20%).

MIX-COMP-THERM-002: All the experiments are selected. The k_{eff} and σ used are the experimental k_{eff} and the experimental σ. Hence, the particle effect bias is not accepted as a model simplification, since the design application will itself involve MOX particles.

MIX-COMP-THERM-003: All cases are selected.

MIX-COMP-THERM-004: All cases are selected.

MIX-COMP-THERM-005: All the experiments are selected. The k_{eff} and σ used are the experimental k_{eff} and the experimental σ. Hence, the particle effect bias is not accepted as a model simplification, since the design application will itself involve MOX particles.

MIX-COMP-THERM-007: This benchmark is not selected because the ^{240}Pu ratio is not in range (^{240}Pu ratio = 24%).

MIX-COMP-THERM-008: This benchmark is not selected because the ^{240}Pu ratio is not in range (^{240}Pu ratio = 24%).

MIX-COMP-THERM-009: All the experiments are selected. The k_{eff} and σ used are the experimental k_{eff} and the experimental σ. Hence, the particle effect bias is not accepted as a model simplification, since the design application will itself involve MOX particles.

MIX-COMP-THERM-010: This benchmark is not selected because the presence of gadolinium in the lattice is not a process situation.

ATTACHMENT NUMBER 2A

AOA(2) CRITICALITY RESULTS FOR SUN PLATFORM

(Sun calculation results)

Experiment	v^m/v^f	PuO_2 content [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
MIX-COMP-THERM_002										
PNL-30	1.19	2 04	1.00018	0 0059	0.9933	0.0012	5.76E-01	600	700	12
PNL-31	1.19	2 04	1.00006	0.0045	0.9961	0.0014	7.67E-01	600	700	20
PNL-32	2.52	2.04	1.00019	0 0027	1.0004	0.0012	1 93E-01	600	700	45
PNL-33	2 52	2.04	1.00022	0 0017	1 0059	0 0012	2 82E-01	600	700	14
PNL-34	3.64	2.04	1.00096	0.0018	1.0028	0.0011	1.38E-01	600	700	16
PNL-35	3 64	2.04	1.00013	0 0020	1 0059	0 0011	1.83E-01	600	700	12
MIX-COMP-THERM_003										
Case 1	1.68	6.6	1.0000	0.0071	0.9911	0 0013	9.09E-01	905	600	24
Case 2-a	2.16	6.6	1.0000	0.0057	0.9939	0 0013	5.49E-01	905	600	7
Case 2-b	2 16	6 6	1 0000	0 0057	0.9964	0 0013	5 48E-01	905	600	21
Case 3	2.16	6 6	1.0000	0 0052	0.9971	0 0012	6 54E-01	905	600	86
Case 4	4.71	6.6	1.0000	0.0028	1.0013	0 0013	1.89E-01	905	600	15
Case 5	5.67	6 6	1.0000	0 0024	1 0011	0.0013	1.56E-01	905	600	24
Case 6	10.75	6 6	1.0000	0 0020	1.0022	0.0013	1.02E-01	905	600	8
MIX-COMP-THERM_004										
Case 1	2 42	3 01	1.0000	0 0046	0 9916	0.0012	1 46E-01	600	700	4
Case 2	2 42	3.01	1.0000	0 0046	0 9940	0 0013	1.45E-01	600	700	6
Case 3	2 42	3 01	1.0000	0 0046	0 9944	0 0013	1.44E-01	600	700	4
Case 4	2.98	3.01	1.0000	0 0039	0 9956	0 0013	1.20E-01	600	700	15
Case 5	2 98	3.01	1.0000	0.0039	0 9952	0 0011	1.19E-01	600	700	30
Case 6	2 98	3.01	1.0000	0.0039	0.9966	0 0013	1.18E-01	600	700	4
Case 7	4 24	3.01	1.0000	0.0040	0.9979	0 0012	9.24E-02	600	700	55
Case 8	4 24	3.01	1.0000	0.0040	0.9979	0 0012	9.24E-02	600	700	13
Case 9	4 24	3 01	1.0000	0 0040	0.9995	0 0013	9 23E-02	600	700	7
Case 10	5 55	3.01	1.0000	0 0051	0.9998	0 0014	7.99E-02	600	700	25
Case 11	5.55	3 01	1.0000	0 0051	1.0000	0 0011	7.95E-02	600	700	15
MIX-COMP-THERM_005										
Case 1	1.93	4 0	1 00000	0 0021	0 9963	0.0012	3.92E-01	700	800	18
Case 2	2.56	4 0	1.00000	0 0023	0.9956	0.0015	2.60E-01	700	800	74
Case 3	3.62	4 0	1.00000	0 0024	1.0041	0 0012	1.77E-01	700	800	33
Case 4	4 53	4 0	1.00000	0 0019	1.0033	0.0014	1.46E-01	700	800	10
Case 5	7.27	4.0	1.00000	0 0025	1.0052	0 0016	1.08E-01	700	800	67
Case 6	10 11	4.0	1.00000	0.0027	1.0069	0 0016	9.35E-02	700	800	17
MIX-COMP-THERM_009										
Case 1	1.10	1.5	1.00000	0.0052	0.9964	0.0010	5.48E-01	800	800	50
Case 2	1.56	1.5	1.00000	0 0040	0.9927	0 0010	3 06E-01	800	800	54
Case 3	2.71	1.5	1 00000	0 0026	0.9943	0 0012	1 57E-01	800	800	22
Case 4	3.79	1.5	1 00000	0 0030	0 9971	0.0009	1.17E-01	800	800	18
Case 5	5.14	1.5	1 00000	0 0038	0.9991	0.0008	9.58E-02	800	800	20
Case 6	5.58	1.5	1.00000	0 0043	1.0004	0.0008	9.16E-02	800	800	25

ATTACHMENT NUMBER 2B

AOA(2) CRITICALITY RESULTS FOR PC PLATFORM

(PC calculation results)

Experiment.	v^m/v^f	PuO_2 content [wt. %]	Exp. k_{eff}	Exp. uncertainty	CSAS26 238GROUP k_{eff}	σ	EALF [eV]	GEN	NPG	NSK
MIX-COMP-THERM_002										
PNL-30	1.19	2 04	1.00018	0 0059	0 9949	0 0006	5.77E-01	1503	1000	7
PNL-31	1.19	2 04	1.00006	0 0045	0.9956	0 0006	7.73E-01	1503	1000	7
PNL-32	2.52	2.04	1.00019	0 0027	1.0004	0 0007	1.93E-01	1503	1000	34
PNL-33	2 52	2 04	1.00022	0 0017	1.0049	0 0006	2.83E-01	1503	1000	7
PNL-34	3 64	2.04	1.00096	0 0018	1.0028	0 0007	1.38E-01	1503	1000	16
PNL-35	3 64	2.04	1.00013	0 0020	1.0067	0 0006	1.83E-01	1503	1000	44
MIX-COMP-THERM_003										
Case 1	1.68	6 6	1.0000	0 0071	0.9922	0 0007	9.08E-01	1503	1000	19
Case 2-a	2 16	6 6	1.0000	0.0057	0.9956	0 0008	5.49E-01	1503	1000	5
Case 2-b	2 16	6 6	1.0000	0 0057	0.9957	0 0007	5.46E-01	1503	1000	36
Case 3	2 16	6 6	1.0000	0 0052	0.9942	0 0007	6.51E-01	1503	1000	16
Case 4	4 71	6 6	1.0000	0 0028	0.9980	0 0008	1.89E-01	1503	1000	15
Case 5	5 67	6 6	1.0000	0 0024	1.0004	0 0007	1.56E-01	1503	1000	37
Case 6	10.75	6 6	1.0000	0 0020	1.0036	0.0007	1.01E-01	1503	1000	35
MIX-COMP-THERM_004										
Case 1	2 42	3.01	1.0000	0 0046	0.9933	0 0006	1.46E-01	1503	1000	32
Case 2	2.42	3.01	1.0000	0 0046	0.9958	0 0008	1.45E-01	1503	1000	43
Case 3	2.42	3.01	1.0000	0 0046	0.9953	0 0006	1 44E-01	1503	1000	4
Case 4	2.98	3.01	1.0000	0 0039	0.9950	0 0007	1.19E-01	1503	1000	10
Case 5	2 98	3.01	1.0000	0 0039	0.9965	0 0007	1.19E-01	1503	1000	13
Case 6	2.98	3.01	1.0000	0 0039	0.9967	0 0007	1.18E-01	1503	1000	5
Case 7	4 24	3.01	1.0000	0 0040	0.9981	0 0007	9.28E-02	1503	1000	28
Case 8	4.24	3.01	1.0000	0 0040	0.9986	0 0006	9.25E-02	1503	1000	35
Case 9	4 24	3.01	1.0000	0 0040	0.9987	0 0006	9.16E-02	1503	1000	4
Case 10	5.55	3.01	1.0000	0 0051	0.9997	0 0006	7.96E-02	1503	1000	50
Case 11	5 55	3.01	1.0000	0 0051	1.0000	0 0006	7.94E-02	1503	1000	14
MIX-COMP-THERM_005										
Case 1	1.93	4.0	1.00000	0 0021	0.9956	0.0007	3.94E-01	1503	1000	16
Case 2	2 56	4.0	1.00000	0 0023	0.9939	0.0007	2.59E-01	1503	1000	32
Case 3	3 62	4.0	1.00000	0.0024	1.0032	0.0008	1.77E-01	1503	1000	7
Case 4	4 53	4.0	1.00000	0.0019	1.0020	0 0007	1.47E-01	1503	1000	14
Case 5	7.27	4.0	1.00000	0 0025	1.0053	0 0007	1.08E-01	1503	1000	62
Case 6	10.11	4.0	1.00000	0 0027	1.0065	0.0006	9 29E-02	1503	1000	10
MIX-COMP-THERM_009										
Case 1	1.10	1.5	1.00000	0 0052	0 9963	0.0006	5.46E-01	1503	1000	129
Case 2	1.56	1.5	1.00000	0 0040	0 9941	0.0006	3 07E-01	1503	1000	65
Case 3	2.71	1.5	1.00000	0 0026	0.9969	0.0006	1.56E-01	1503	1000	13
Case 4	3.79	1.5	1.00000	0 0030	0 9978	0.0006	1.17E-01	1503	1000	35
Case 5	5.14	1.5	1.00000	0 0038	0 9992	0.0006	9 62E-02	1503	1000	47
Case 6	5.58	1.5	1.00000	0 0043	0 9996	0.0006	9.16E-02	1503	1000	67

ATTACHMENT NUMBER 3

OUTPUT LISTING OF USLSTATS V1.0 PROGRAM

FOR PC PLATFORM

Figure A3–1 AOA(1) – k_{eff} versus EALF as trending parameter – SCALE 4.4a on PC

```
uslstats· a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

 Input to statistical treatment from file:toto.inp

Title: AOA(1) PC full set EALF

 Proportion of the population = .999
 Confidence of fit            = .950
 Confidence on proportion     = .950
 Number of observations       =  191
 Minimum value of closed band =    0.00
 Maximum value of closed band =    0.00
 Administrative margin        =    0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
8.79564E-02	1.00910E+00	5.14198E-03	1.67337E-01	1.00580E+00	3.32415E-03
1.10854E-01	1.00970E+00	5 06360E-03	1.66955E-01	1.00730E+00	3.29849E-03
1.34839E-01	1.01150E+00	5 06360E-03	1.66546E-01	1.00900E+00	3.32415E-03
1.50757E-01	1.00590E+00	5.06360E-03	1.68373E-01	1.00970E+00	4.37379E-03
1.59544E-01	1.00920E+00	5.06360E-03	1.67903E-01	1.00630E+00	4.39318E-03
3.46678E-01	1.00870E+00	5 06360E-03	1.67166E-01	1.00900E+00	4.37379E-03
7.12128E-02	1.00770E+00	4.76760E-03	1.66898E-01	1.00770E+00	4.39318E-03
7.28617E-02	1.00770E+00	4.76760E-03	1.66630E-01	1 00750E+00	4.39318E-03
7.78800E-02	1.00830E+00	4.75184E-03	1.68449E-01	1.01000E+00	4.39318E-03
8.13967E-02	1.01000E+00	4.78539E-03	1.67790E-01	1.00690E+00	4.41475E-03
8.50698E-02	1.01150E+00	4.76760E-03	1.66997E-01	1.00880E+00	4.39318E-03
9.29137E-02	1.00820E+00	4.76760E-03	1.66691E-01	1.00830E+00	4.37379E-03
1.00322E-01	1.01030E+00	4.76760E-03	1.66682E-01	1.00800E+00	4.39318E-03
5.83795E-02	1.00620E+00	4.76760E-03	1.66969E-01	1.00730E+00	4.39318E-03
5.95793E-02	1.00680E+00	4.76760E-03	1.68612E-01	1.01020E+00	4.37379E-03
6.18997E-02	1.00780E+00	4.76760E-03	1.67699E-01	1.00620E+00	4.39318E-03
6.26929E-02	1.00920E+00	4.75184E-03	1.67331E-01	1.00880E+00	4.39318E-03
6.54388E-02	1.01000E+00	4.76760E-03	1.66818E-01	1.00790E+00	4.39318E-03
6.94428E-02	1.00990E+00	4.78539E-03	1.66664E-01	1.00730E+00	4.39318E-03
5.91641E-02	1.01060E+00	4.76760E-03	1.66641E-01	1.00770E+00	4 39318E-03
6.01058E-02	1.01000E+00	4.75184E-03	1.68215E-01	1.00710E+00	4.37379E-03
5.33828E-02	1 00630E+00	4.76760E-03	1.68357E-01	1.00590E+00	4.39318E-03
5.36833E-02	1.00360E+00	4.75184E-03	1 67772E-01	1.00650E+00	4.39318E-03
5.47121E-02	1.00610E+00	4.75184E-03	1.67416E-01	1.00830E+00	4.37379E-03
5.59714E-02	1.00380E+00	4.75184E-03	1.67630E-01	1.00630E+00	4 41475E-03
5.45435E-02	1.00450E+00	4.75184E-03	1 67462E-01	1.00700E+00	4.41475E-03
5.48712E-02	1.00650E+00	4.76760E-03	2 37509E-01	1.00930E+00	3.90513E-03
5.58159E-02	1.01080E+00	4.76760E-03	2.36912E-01	1.01000E+00	3.88330E-03
5.65395E-02	1.00700E+00	4.75184E-03	2 36543E-01	1.00790E+00	3.90513E-03
5.85551E-02	1.00460E+00	4.75184E-03	2.36831E-01	1.00830E+00	3.90513E-03
6.31817E-02	1.00660E+00	4.76760E-03	2.36587E-01	1.00670E+00	3.90513E-03
6.85846E-02	1.00400E+00	4.75184E-03	2.36202E-01	1.00930E+00	3.88330E-03
5.58595E-02	1.00770E+00	4.75184E-03	2.38483E-01	1.01040E+00	4.78539E-03
5.56140E-02	1.00590E+00	4.75184E-03	2.37274E-01	1.00990E+00	4.78539E-03
5.55403E-02	1.00850E+00	4.75184E-03	2.36695E-01	1.00970E+00	4.76760E-03
5.65552E-02	1.00740E+00	4.75184E-03	2.36058E-01	1.00840E+00	4.78539E-03
5.76214E-02	1.00780E+00	4.76760E-03	2.38161E-01	1.00690E+00	4.78539E-03
6.00338E-02	1.01060E+00	4.76760E-03	2.37891E-01	1.00650E+00	4.76760E-03
6.29144E-02	1.01010E+00	4.75184E-03	2.36841E-01	1.00890E+00	4.78539E-03
6.60208E-02	1.01040E+00	4.75184E-03	2.36296E-01	1.00960E+00	4.78539E-03
6.92278E-02	1.00830E+00	4 78539E-03	2.38548E-01	1.01000E+00	4.76760E-03
5.66741E-02	1.00510E+00	4 75184E-03	2.38276E-01	1.00820E+00	4.78539E-03
5.79244E-02	1 00700E+00	4 75184E-03	2.37141E-01	1.00910E+00	4.78539E-03
5.24565E-02	1.00500E+00	3.59027E-03	2.37431E-01	1.00810E+00	4.39318E-03
5.33009E-02	1.00620E+00	3.56931E-03	2.36989E-01	1.00730E+00	4.39318E-03
5.52206E-02	1.00630E+00	3.56931E-03	2.36537E-01	1.00910E+00	4.39318E-03
6.48964E-02	1.01370E+00	3.39559E-03	2.36458E-01	1.00880E+00	4.39318E-03
7.83975E-02	1.01590E+00	4.07922E-03	1.67942E-01	1.00740E+00	3.90513E-03

7.94782E-02	1.02270E+00	4.07922E-03	1.67467E-01	1.00750E+00	3.90513E-03
8.00708E-02	1.02740E+00	4.06079E-03	1.67208E-01	1.01010E+00	3.90513E-03
6.02411E-02	1.02820E+00	2 88617E-03	1.66786E-01	1.01080E+00	3.90513E-03
5.71888E-02	1.02200E+00	2.88617E-03	1.65519E-01	1.00960E+00	3.42053E-03
8.72767E-02	1.00140E+00	4.07922E-03	1.66435E-01	1.00870E+00	3.44819E-03
5.48519E-01	1.00710E+00	6.15224E-03	1.67131E-01	1.01010E+00	3.42053E-03
7.52280E-02	1.03170E+00	3.76563E-03	1.66869E-01	1.00730E+00	3.90513E-03
6.61882E-02	1.02640E+00	3.17805E-03	1.66968E-01	1.00880E+00	3.90513E-03
9.96842E-02	1.02190E+00	4 19762E-03	1.67120E-01	1.00830E+00	3 90513E-03
7.66779E-02	1.02750E+00	4 17732E-03	1.67064E-01	1.00800E+00	3.88330E-03
1.07278E-01	1.00740E+00	4.27551E-03	1.67223E-01	1.00930E+00	3 90513E-03
7.43597E-02	1.01720E+00	4.17732E-03	1.67150E-01	1.00870E+00	3 90513E-03
6.52939E-02	1.02070E+00	3.39559E-03	1.67269E-01	1.00690E+00	3 92938E-03
7.95316E-02	1.01760E+00	4.07922E-03	1.67189E-01	1.00830E+00	3.92938E-03
8.01910E-02	1.02470E+00	4 06079E-03	1.67010E-01	1.00900E+00	3.92938E-03
6.04976E-02	1.02000E+00	2.88617E-03	1.67538E-01	1.00780E+00	3.90513E-03
5.74725E-02	1.01950E+00	2 91204E-03	1.66900E-01	1.00890E+00	3 90513E-03
8.59860E-02	1.00220E+00	4.07922E-03	1.66967E-01	1.00870E+00	3 92938E-03
5.20183E-01	9.94800E-01	6.15224E-03	1.67078E-01	1.00910E+00	3.90513E-03
7.71986E-02	1.02460E+00	3 78550E-03	1.67248E-01	1.00920E+00	3.90513E-03
6.68322E-02	1.01870E+00	3.17805E-03	1.66704E-01	1.01020E+00	3.88330E-03
9.94312E-02	1.02080E+00	4 27551E-03	1.66824E-01	1.01010E+00	3.90513E-03
7.91584E-02	1.02040E+00	4 17732E-03	1.66972E-01	1.00880E+00	3.90513E-03
1.46679E-01	1.01290E+00	4.29535E-03	1.66697E-01	1.00950E+00	3 90513E-03
1.15325E-01	1.00620E+00	4.27551E-03	6.56132E-02	1.00800E+00	5 95399E-03
8.03191E-02	1.02080E+00	4.19762E-03	6.46606E-02	1.01040E+00	5 94138E-03
7.49507E-02	1.01800E+00	4.17732E-03	5.88638E-02	1.00540E+00	5.95399E-03
6.33838E-02	1.01550E+00	5 26118E-03	7.62407E-02	1.00870E+00	5.94138E-03
5.20005E-02	9.99800E-01	5.24690E-03	7.91837E-02	1.00730E+00	5.94138E-03
6.46684E-02	1.02090E+00	5.26118E-03	6.03194E-02	1.00220E+00	5.95399E-03
5.29627E-02	1.00550E+00	5.26118E-03	1.05952E-01	1.00690E+00	5 96825E-03
6.71864E-02	1.02070E+00	5.26118E-03	7.60457E-02	9.98900E-01	5 95399E-03
5.28973E-02	1.00230E+00	5.24690E-03	6.49151E-02	1.00880E+00	5.95399E-03
6.78595E-02	1.01320E+00	5.27731E-03	5.86666E-02	1.00580E+00	5 95399E-03
5.41435E-02	9.99400E-01	5.26118E-03	7.60094E-02	1.00720E+00	5.95399E-03
7.53575E-02	1.01020E+00	5.26118E-03	7.91953E-02	1.00870E+00	5.95399E-03
5.55823E-02	1.01050E+00	5 26118E-03	7.60421E-02	1.00020E+00	5.96825E-03
5.93469E-02	1.00640E+00	5.26118E-03	1.06379E-01	1.00170E+00	5 95399E-03
5.39823E-02	1.00630E+00	5.26118E-03	7.87037E-02	1.01490E+00	3 92046E-03
1.67812E-01	1.00910E+00	3.29849E-03	7.88171E-02	1.01590E+00	3 93192E-03
1.67457E-01	1.00790E+00	3.32415E-03	7.90645E-02	1.01580E+00	3 93192E-03
1.66807E-01	1.01000E+00	3.32415E-03	7.96660E-02	1.01500E+00	3 92046E-03
1.67233E-01	1.00800E+00	3.29849E-03	8.02144E-02	1.01250E+00	3 92046E-03
1.66668E-01	1.00940E+00	3 32415E-03	8.05826E-02	1.00890E+00	3 92046E-03
1.66668E-01	1.00800E+00	3.32415E-03	8.82228E-02	9.97100E-01	5.22398E-03
1.68142E-01	1.00790E+00	3.32415E-03	8.89412E-02	9.96500E-01	5 21536E-03
1.67636E-01	1.00750E+00	3.29849E-03	8.89815E-02	9.97100E-01	5 12445E-03
1.67279E-01	1.00720E+00	3.29849E-03			

chi = 92.4817 (upper bound = 9.49). The data tests NOT normal

Output from statistical treatment

AOA(1) PC full set EALF

Number of data points (n)	191
Linear regression, k(X)	1.0114 + (-1.5297E-02)*X
Confidence on fit (1-gamma) [input]	95.0%
Confidence on proportion (alpha) [input]	95.0%
Proportion of population falling above lower tolerance interval (rho) [input]	99.9%
Minimum value of X	0.0520
Maximum value of X	0.5485
Average value of X	0.12713
Average value of k	1.00950
Minimum value of k	0.99480
Variance of fit, s(k,X)^2	3.1856E-05
Within variance, s(w)^2	2 0287E-05
Pooled variance, s(p)^2	5.2143E-05
Pooled std. deviation, s(p)	7.2210E-03
C(alpha,rho)*s(p)	4.1459E-02
student-t @ (n-2,1-gamma)	1.64500E+00
Confidence band width, W	1.2842E-02
Minimum margin of subcriticality, C*s(p)-W	2.8617E-02

Upper subcritical limits: (5.20005E-02 <= X <= 0.54852)
***** ********** *******

```
USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0.9372 ( 5.20005E-2< X < 0.54852   )

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9585 ( 5.20005E-2< X < 0.54852   )


USLs Evaluated Over Range of Parameter X
**** ********* **** ***** ** ********* **

X:  5.20E-2  1.23E-1  1.94E-1  2.65E-1  3.36E-1  4.07E-1  4.78E-1  5.49E-1
    ---------------------------------------------------------------------
USL-1:   0.9372   0.9372   0.9372   0.9372   0 9372   0.9372   0.9372   0.9372
USL-2·   0.9585   0.9585   0.9585   0.9585   0.9585   0.9585   0 9585   0.9585
    ---------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A3–2 AOA(1) – k_{eff} versus H/Pu as trending parameter – SCALE 4.4a on PC

```
uslstats: a utility to calculate upper subcritical
                    limits for criticality safety applications

  ****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
  ****************************************************************************


   Input to statistical treatment from file.toto.inp

Title· AOA(1) full set H/Pu

   Proportion of the population = .999
   Confidence of fit            = .950
   Confidence on proportion     = .950
   Number of observations       =  191
   Minimum value of closed band =    0.00
   Maximum value of closed band =    0.00
   Administrative margin        =    0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
3.52910E+02	1.00910E+00	5.14198E-03	2.10180E+02	1.00580E+00	3.32415E-03
2.58050E+02	1.00970E+00	5.06360E-03	2.10180E+02	1.00730E+00	3.29849E-03
2.05140E+02	1.01150E+00	5.06360E-03	2.10180E+02	1.00900E+00	3.32415E-03
1.80970E+02	1.00590E+00	5.06360E-03	2.10180E+02	1.00970E+00	4.37379E-03
1.71210E+02	1.00920E+00	5.06360E-03	2.10180E+02	1.00630E+00	4.39318E-03
8 66600E+01	1.00870E+00	5.06360E-03	2.10180E+02	1.00900E+00	4.37379E-03
5 07980E+02	1.00770E+00	4.76760E-03	2 10180E+02	1.00770E+00	4.39318E-03
4 89180E+02	1.00770E+00	4.76760E-03	2.10180E+02	1.00750E+00	4.39318E-03
4.37280E+02	1.00830E+00	4.75184E-03	2.10180E+02	1.01000E+00	4.39318E-03
4.07450E+02	1.01000E+00	4.78539E-03	2.10180E+02	1.00690E+00	4.41475E-03
3.80570E+02	1.01150E+00	4.76760E-03	2.10180E+02	1.00880E+00	4.39318E-03
3.33540E+02	1.00820E+00	4.76760E-03	2 10180E+02	1.00830E+00	4.37379E-03
2.99260E+02	1.01030E+00	4.76760E-03	2.10180E+02	1.00800E+00	4.39318E-03
7.74150E+02	1.00620E+00	4.76760E-03	2 10180E+02	1.00730E+00	4.39318E-03
7.42710E+02	1.00680E+00	4.76760E-03	2.10180E+02	1.01020E+00	4.37379E-03
6.77170E+02	1.00780E+00	4.76760E-03	2.10180E+02	1.00620E+00	4.39318E-03
6.60550E+02	1.00920E+00	4.75184E-03	2.10180E+02	1.00880E+00	4.39318E-03
6.07170E+02	1.01000E+00	4.76760E-03	2.10180E+02	1.00790E+00	4.39318E-03
5.45330E+02	1.00990E+00	4.78539E-03	2.10180E+02	1.00730E+00	4.39318E-03
7.14830E+02	1.01060E+00	4.76760E-03	2 10180E+02	1.00770E+00	4.39318E-03
6.92120E+02	1.01000E+00	4.75184E-03	2 10180E+02	1.00710E+00	4.37379E-03
9 81670E+02	1.00630E+00	4.76760E-03	2 10180E+02	1.00590E+00	4.39318E-03
9.71630E+02	1.00360E+00	4.75184E-03	2 10180E+02	1.00650E+00	4.39318E-03
9.29600E+02	1.00610E+00	4.75184E-03	2.10180E+02	1.00830E+00	4.37379E-03
8.84120E+02	1.00380E+00	4.75184E-03	2 10180E+02	1.00630E+00	4.41475E-03
9.25520E+02	1.00450E+00	4.75184E-03	2 10180E+02	1.00700E+00	4.41475E-03
8.98580E+02	1.00650E+00	4.76760E-03	1 55210E+02	1.00930E+00	3.90513E-03
8.64010E+02	1.01080E+00	4.76760E-03	1.55270E+02	1.01000E+00	3.88330E-03
8.41980E+02	1.00700E+00	4.75184E-03	1 55270E+02	1.00790E+00	3.90513E-03
7.80210E+02	1.00460E+00	4.75184E-03	1.55270E+02	1.00830E+00	3.90513E-03
6.67980E+02	1.00660E+00	4.76760E-03	1.55270E+02	1.00670E+00	3.90513E-03
5.73340E+02	1.00400E+00	4.75184E-03	1.55270E+02	1.00930E+00	3.88330E-03
8.65010E+02	1.00770E+00	4.75184E-03	1 55270E+02	1.01040E+00	4.78539E-03
8.72210E+02	1.00590E+00	4.75184E-03	1.55270E+02	1.00990E+00	4.78539E-03
8.66360E+02	1.00850E+00	4.75184E-03	1.55270E+02	1.00970E+00	4.76760E-03
8.32710E+02	1.00740E+00	4.75184E-03	1.55270E+02	1.00840E+00	4.78539E-03
8.00710E+02	1.00780E+00	4.76760E-03	1.55270E+02	1.00690E+00	4.78539E-03
7.34370E+02	1.01060E+00	4.76760E-03	1.55270E+02	1.00650E+00	4.76760E-03
6 66080E+02	1.01010E+00	4.75184E-03	1.55270E+02	1.00890E+00	4.78539E-03
6.07890E+02	1.01040E+00	4.75184E-03	1.55270E+02	1.00960E+00	4.78539E-03
5.57170E+02	1.00830E+00	4.78539E-03	1.55270E+02	1.01000E+00	4.76760E-03
8.30640E+02	1.00510E+00	4 75184E-03	1.55270E+02	1.00820E+00	4.78539E-03
7.88950E+02	1.00700E+00	4 75184E-03	1.55270E+02	1.00910E+00	4.78539E-03
1.02816E+03	1.00500E+00	3.59027E-03	1.55270E+02	1 00810E+00	4.39318E-03
9.86180E+02	1.00620E+00	3.56931E-03	1.55270E+02	1.00730E+00	4.39318E-03
9.10900E+02	1.00630E+00	3.56931E-03	1.55270E+02	1.00910E+00	4.39318E-03
6.83880E+02	1.01370E+00	3.39559E-03	1.55270E+02	1.00880E+00	4.39318E-03
4.95930E+02	1.01590E+00	4.07922E-03	2.10180E+02	1.00740E+00	3.90513E-03
4.88550E+02	1.02270E+00	4.07922E-03	2.10170E+02	1.00750E+00	3.90513E-03

4.86150E+02	1.02740E+00	4.06079E-03	2.10170E+02	1.01010E+00	3.90513E-03
7.82400E+02	1.02820E+00	2.88617E-03	2.10170E+02	1.01080E+00	3.90513E-03
8.67100E+02	1.02200E+00	2.88617E-03	2.10170E+02	1.00960E+00	3.42053E-03
4.54500E+02	1.00140E+00	4.07922E-03	2.10170E+02	1.00870E+00	3.44819E-03
8.50300E+01	1.00710E+00	6.15224E-03	2 10170E+02	1.01010E+00	3.42053E-03
5.21450E+02	1.03170E+00	3.76563E-03	2.10180E+02	1.00730E+00	3.90513E-03
6.50830E+02	1.02640E+00	3.17805E-03	2 10180E+02	1.00880E+00	3.90513E-03
3.44020E+02	1.02190E+00	4.19762E-03	2.10180E+02	1.00830E+00	3.90513E-03
4 99920E+02	1 02750E+00	4.17732E-03	2.10180E+02	1.00800E+00	3.88330E-03
3.28020E+02	1 00740E+00	4.27551E-03	2.10180E+02	1.00930E+00	3.90513E-03
5 38180E+02	1.01720E+00	4.17732E-03	2.10180E+02	1.00870E+00	3.90513E-03
6.73070E+02	1.02070E+00	3.39559E-03	2.10180E+02	1.00690E+00	3.92938E-03
4.88550E+02	1.01760E+00	4.07922E-03	2.10180E+02	1.00830E+00	3.92938E-03
4.86150E+02	1.02470E+00	4.06079E-03	2.10180E+02	1.00900E+00	3.92938E-03
7.76810E+02	1.02000E+00	2.88617E-03	2.10180E+02	1.00780E+00	3.90513E-03
8.56600E+02	1.01950E+00	2.91204E-03	2.10180E+02	1.00890E+00	3.90513E-03
4.62990E+02	1.00220E+00	4.07922E-03	2.10180E+02	1.00870E+00	3.92938E-03
8.84300E+01	9.94800E-01	6.15224E-03	2.10180E+02	1.00910E+00	3.90513E-03
4.96980E+02	1.02460E+00	3.78550E-03	2.10180E+02	1.00920E+00	3.90513E-03
6.39340E+02	1.01870E+00	3.17805E-03	2.10180E+02	1 01020E+00	3 88330E-03
3.44020E+02	1.02080E+00	4 27551E-03	2.10180E+02	1.01010E+00	3.90513E-03
4.74900E+02	1.02040E+00	4.17732E-03	2.10180E+02	1.00880E+00	3.90513E-03
2.32010E+02	1.01290E+00	4 29535E-03	2.10180E+02	1.00950E+00	3.90513E-03
3.01120E+02	1.00620E+00	4.27551E-03	6.03570E+02	1.00800E+00	5.95399E-03
4.75390E+02	1.02080E+00	4.19762E-03	6.21120E+02	1.01040E+00	5.94138E-03
5.31210E+02	1.01800E+00	4.17732E-03	7.47180E+02	1.00540E+00	5.95399E-03
7.33000E+02	1.01550E+00	5.26118E-03	4.62510E+02	1.00870E+00	5.94138E-03
1.15729E+03	9.99800E-01	5.24690E-03	4.51850E+02	1.00730E+00	5.94138E-03
7.05450E+02	1.02090E+00	5.26118E-03	7.23850E+02	1.00220E+00	5.95399E-03
1.10319E+03	1.00550E+00	5.26118E-03	3.42960E+02	1.00690E+00	5.96825E-03
6.62770E+02	1.02070E+00	5.26118E-03	5.40110E+02	9.98900E-01	5.95399E-03
1.10978E+03	1.00230E+00	5.24690E-03	6.17240E+02	1.00880E+00	5.95399E-03
6.53420E+02	1.01320E+00	5.27731E-03	7.53990E+02	1.00580E+00	5.95399E-03
1.05374E+03	9.99400E-01	5.26118E-03	4.65800E+02	1.00720E+00	5.95399E-03
5 50660E+02	1.01020E+00	5.26118E-03	4.51850E+02	1.00870E+00	5.95399E-03
9 95410E+02	1.01050E+00	5.26118E-03	5.40110E+02	1.00020E+00	5.96825E-03
8 70370E+02	1.00640E+00	5.26118E-03	3.41170E+02	1.00170E+00	5.95399E-03
1.05643E+03	1.00630E+00	5.26118E-03	4.24340E+02	1.01490E+00	3.92046E-03
2.10180E+02	1.00910E+00	3.29849E-03	4.24340E+02	1.01590E+00	3.93192E-03
2.10180E+02	1.00790E+00	3.32415E-03	4.24340E+02	1.01580E+00	3.93192E-03
2.10180E+02	1.01000E+00	3.32415E-03	4.24340E+02	1.01500E+00	3.92046E-03
2.10180E+02	1.00800E+00	3.29849E-03	4.24340E+02	1.01250E+00	3 92046E-03
2.10180E+02	1.00940E+00	3.32415E-03	4.24340E+02	1.00890E+00	3 92046E-03
2.10180E+02	1.00800E+00	3.32415E-03	4.30260E+02	9.97100E-01	5.22398E-03
2.10180E+02	1.00790E+00	3 32415E-03	4.25560E+02	9.96500E-01	5.21536E-03
2.10180E+02	1.00750E+00	3.29849E-03	4.25270E+02	9.97100E-01	5.12445E-03
2.10180E+02	1.00720E+00	3.29849E-03			

chi = 92.4817 (upper bound = 9.49). The data tests NOT normal

Output from statistical treatment

AOA(1) full set H/Pu

Number of data points (n)	191
Linear regression, k(X)	1.0091 + (8.1036E-07)*X
Confidence on fit (1-gamma) [input]	95 0%
Confidence on proportion (alpha) [input]	95.0%
Proportion of population falling above lower tolerance interval (rho) [input]	99.9%
Minimum value of X	85 0300
Maximum value of X	1157.2900
Average value of X	433.28293
Average value of k	1.00950
Minimum value of k	0.99480
Variance of fit, s(k,X)^2	3.3151E-05
Within variance, s(w)^2	2 0287E-05
Pooled variance, s(p)^2	5.3438E-05
Pooled std. deviation, s(p)	7 3101E-03
C(alpha,rho)*s(p)	3.8993E-02
student-t @ (n-2,1-gamma)	1.64500E+00
Confidence band width, W	1.2273E-02
Minimum margin of subcriticality, C*s(p)-W	2.6720E-02

Upper subcritical limits (85.030 <= X <= 1157.3)
***** *********** *******

USL Method 1 (Confidence Band with

```
Administrative Margin)            USL1 = 0.9377 (  85.030   < X <  1157.3   )

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9610 (  85.030   < X <  1157.3   )


USLs Evaluated Over Range of Parameter X.
**** ********* **** ***** ** ********* **

X:  8.50E+1  2.38E+2  3.91E+2  5.45E+2  6.98E+2  8.51E+2  1.00E+3  1.16E+3
   ---------------------------------------------------------------------
USL-1:   0.9377   0.9377   0.9377   0 9377   0.9377   0.9377   0.9377   0.9377
USL-2:   0.9610   0.9610   0.9610   0.9610   0.9610   0.9610   0.9610   0 9610
   ---------------------------------------------------------------------

*******************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A3–3 AOA(1) – k_{eff} versus ^{240}Pu content as trending parameter – SCALE 4.4a on PC

```
          uslstats: a utility to calculate upper subcritical
                    limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

  Input to statistical treatment from file·toto.inp

Title: AOA(1) Pu content Pu240

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  46
  Minimum value of closed band =   0 00
  Maximum value of closed band =   0.00
  Administrative margin        =   0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
4.67000E+00	1.00910E+00	5.14198E-03	5.40000E-01	1.00610E+00	4.75184E-03
4.67000E+00	1.00970E+00	5.06360E-03	5.40000E-01	1.00380E+00	4.75184E-03
4.67000E+00	1.01150E+00	5.06360E-03	1.76000E+00	1.00450E+00	4.75184E-03
4.67000E+00	1.00590E+00	5.06360E-03	3.12000E+00	1.00650E+00	4.76760E-03
4.67000E+00	1.00920E+00	5.06360E-03	3.12000E+00	1.01080E+00	4.76760E-03
4.67000E+00	1.00870E+00	5.06360E-03	3.12000E+00	1.00700E+00	4.75184E-03
3.12000E+00	1.00770E+00	4.76760E-03	3.12000E+00	1.00460E+00	4.75184E-03
3.12000E+00	1.00770E+00	4.76760E-03	3.12000E+00	1.00660E+00	4.76760E-03
3.12000E+00	1.00830E+00	4.75184E-03	3.12000E+00	1.00400E+00	4.75184E-03
3.12000E+00	1.01000E+00	4.78539E-03	3.12000E+00	1.00770E+00	4.75184E-03
3.12000E+00	1.01150E+00	4.76760E-03	3.43000E+00	1.00590E+00	4.75184E-03
3.12000E+00	1.00820E+00	4.76760E-03	4.05000E+00	1.00850E+00	4.75184E-03
3.12000E+00	1.01030E+00	4.76760E-03	4.05000E+00	1.00740E+00	4.75184E-03
1.76000E+00	1.00620E+00	4.76760E-03	4.05000E+00	1.00780E+00	4.76760E-03
1.76000E+00	1.00680E+00	4.76760E-03	4.05000E+00	1.01060E+00	4.76760E-03
3.12000E+00	1.00780E+00	4.76760E-03	4.05000E+00	1.01010E+00	4.75184E-03
3.12000E+00	1.00920E+00	4.75184E-03	4.05000E+00	1.01040E+00	4.75184E-03
3.12000E+00	1.01000E+00	4.76760E-03	4.05000E+00	1.00830E+00	4.78539E-03
3.12000E+00	1.00990E+00	4.78539E-03	4.40000E+00	1.00510E+00	4.75184E-03
3.12000E+00	1.01060E+00	4.76760E-03	4.40000E+00	1.00700E+00	4.75184E-03
3.12000E+00	1.01000E+00	4.75184E-03	3.12000E+00	1.00500E+00	3.59027E-03
5.40000E-01	1.00630E+00	4.76760E-03	3.12000E+00	1.00620E+00	3.56931E-03
5.40000E-01	1.00360E+00	4.75184E-03	3.12000E+00	1.00630E+00	3.56931E-03

```
  chi =  3.5652 (upper bound = 9.49). The data tests normal


       Output from statistical treatment

  AOA(1) Pu content Pu240

   Number of data points (n)                        46
   Linear regression, k(X)                          1.0048 + ( 9.2819E-04)*X
   Confidence on fit (1-gamma) [input]              95.0%
   Confidence on proportion (alpha) [input]         95.0%
   Proportion of population falling above
   lower tolerance interval (rho) [input]           99.9%
   Minimum value of X                                 0.5400
   Maximum value of X                                 4.6700
   Average value of X                                 3.21304
   Average value of k                               1.00779
   Minimum value of k                               1.00360
   Variance of fit, s(k,X)^2                        3.6868E-06
   Within variance, s(w)^2                          2.2431E-05
   Pooled variance, s(p)^2                          2.6118E-05
   Pooled std. deviation, s(p)                      5.1106E-03
   C(alpha,rho)*s(p)                                2.3960E-02
```

```
student-t @ (n-2,1-gamma)                          1.68140E+00
Confidence band width, W                           9.2157E-03
Minimum margin of subcriticality, C*s(p)-W         1.4744E-02

Upper subcritical limits: ( 0.54000     <= X <=   4.6700    )
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0.9408 ( 0.54000   < X <  4.6700   )

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9760 ( 0.54000   < X <  4.6700   )


USLs Evaluated Over Range of Parameter X·
**** ********* **** ***** ** ********* **

X:  5.40E-1  1.13E+0  1.72E+0  2.31E+0  2.90E+0  3.49E+0  4.08E+0  4.67E+0
   ---------------------------------------------------------------------------
USL-1:   0 9408   0.9408   0.9408   0.9408   0.9408   0.9408   0.9408   0.9408
USL-2:   0 9760   0.9760   0.9760   0.9760   0.9760   0.9760   0.9760   0.9760
   ---------------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A3–4 AOA(2) – k_{eff} versus EALF as trending parameter – SCALE 4.4a on PC

```
uslstats  a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

 Input to statistical treatment from file:toto inp

Title· AOA(2) MIX full set EALF

 Proportion of the population = .999
 Confidence of fit            = .950
 Confidence on proportion     = .950
 Number of observations       =  36
 Minimum value of closed band =   0.00
 Maximum value of closed band =   0.00
 Administrative margin        =   0 05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
5.76975E-01	9.94700E-01	5.93043E-03	1.17852E-01	9.96700E-01	3.96232E-03
7.72991E-01	9.95500E-01	4.53982E-03	9.27500E-02	9.98100E-01	4.06079E-03
1.92667E-01	1.00020E+00	2.78927E-03	9.25340E-02	9.98600E-01	4.04475E-03
2.83406E-01	1.00470E+00	1.80278E-03	9.16020E-02	9.98700E-01	4.04475E-03
1.37835E-01	1.00180E+00	1.93132E-03	7.95960E-02	9.99700E-01	5.13517E-03
1.82640E-01	1.00660E+00	2.08806E-03	7 94010E-02	1.00000E+00	5.13517E-03
9.08459E-01	9 92200E-01	7.15433E-03	3.93591E-01	9.95600E-01	2.21359E-03
5.48741E-01	9.95600E-01	5.78558E-03	2.58965E-01	9.93900E-01	2.40416E-03
5.46028E-01	9 95700E-01	5.77260E-03	1.76572E-01	1.00320E+00	2.52982E-03
6.51324E-01	9 94200E-01	5.26673E-03	1.46536E-01	1.00200E+00	2.02485E-03
1.88606E-01	9.98000E-01	2 94090E-03	1.07841E-01	1 00530E+00	2.59615E-03
1.56232E-01	1 00040E+00	2.45204E-03	9.29310E-02	1 00650E+00	2.76586E-03
1.01290E-01	1.00360E+00	2.09067E-03	5.45635E-01	9 97600E-01	5.23450E-03
1.45559E-01	9.93300E-01	4.63897E-03	3.06613E-01	9 94800E-01	4.04475E-03
1.44786E-01	9.95800E-01	4.66905E-03	1.56238E-01	9.97700E-01	2.66833E-03
1.44219E-01	9.95300E-01	4.63897E-03	1.17437E-01	9.98600E-01	3.05941E-03
1.19304E-01	9.95000E-01	3.96232E-03	9.61990E-02	9.99700E-01	3.84708E-03
1.19169E-01	9.96500E-01	3.96232E-03	9.16430E-02	9.99600E-01	4.34166E-03

```
 chi =  0.3889 (upper bound = 9.49). The data tests normal.


      Output from statistical treatment

 AOA(2) MIX full set EALF

 Number of data points (n)                          36
 Linear regression, k(X)                            1.0007 + (-8.7123E-03)*X
 Confidence on fit (1-gamma) [input]                95 0%
 Confidence on proportion (alpha) [input]           95.0%
 Proportion of population falling above
 lower tolerance interval (rho) [input]             99.9%
 Minimum value of X                                   0.0794
 Maximum value of X                                   0.9085
 Average value of X                                   0.24900
 Average value of k                                 0.99848
 Minimum value of k                                 0.99220
 Variance of fit, s(k,X)^2                          1.1132E-05
 Within variance, s(w)^2                            1.6194E-05
 Pooled variance, s(p)^2                            2.7326E-05
 Pooled std  deviation, s(p)                        5.2274E-03
 C(alpha,rho)*s(p)                                  2.6833E-02
 student-t @ (n-2,1-gamma)                          1.69180E+00
 Confidence band width, W                           1.0036E-02
 Minimum margin of subcriticality, C*s(p)-W         1.6797E-02

 Upper subcritical limits: ( 7.94010E-02 <= X <=  0.90846    )
```

```
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0.9406 + (-8.7123E-03)*X

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9738 + (-8.7123E-03)*X


USLs Evaluated Over Range of Parameter X
**** ********* **** ***** ** ********* **

X    7.94E-2  1.98E-1  3.16E-1  4.35E-1  5.53E-1  6.72E-1  7.90E-1  9.08E-1
     ---------------------------------------------------------------------
USL-1·  0.9399   0.9389   0.9379   0.9368   0.9358   0.9348   0.9337   0.9327
USL-2   0.9731   0.9721   0.9711   0.9700   0.9690   0.9680   0.9669   0.9659
     ---------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A3–5 AOA(2) – k_{eff} versus v^m/v^f as trending parameter – SCALE 4.4a on PC

```
uslstats: a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

  Input to statistical treatment from file:toto.inp

Title  AOA(2) MIX full set Vm/Vf

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  36
  Minimum value of closed band =   0.00
  Maximum value of closed band =   0.00
  Administrative margin        =   0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
1.19000E+00	9.94700E-01	5.93043E-03	2.98000E+00	9.96700E-01	3 96232E-03
1.19000E+00	9.95500E-01	4.53982E-03	4.24000E+00	9.98100E-01	4.06079E-03
2.52000E+00	1.00020E+00	2.78927E-03	4.24000E+00	9.98600E-01	4.04475E-03
2.52000E+00	1.00470E+00	1.80278E-03	4.24000E+00	9.98700E-01	4.04475E-03
3.64000E+00	1.00180E+00	1.93132E-03	5.55000E+00	9.99700E-01	5.13517E-03
3.64000E+00	1.00660E+00	2.08806E-03	5.55000E+00	1.00000E+00	5.13517E-03
1.68000E+00	9.92200E-01	7.15433E-03	1 93000E+00	9.95600E-01	2.21359E-03
2.16000E+00	9.95600E-01	5.78558E-03	2.56000E+00	9.93900E-01	2.40416E-03
2.16000E+00	9.95700E-01	5.77260E-03	3.62000E+00	1.00320E+00	2.52982E-03
2.16000E+00	9.94200E-01	5.26673E-03	4.53000E+00	1.00200E+00	2.02485E-03
4.71000E+00	9.98000E-01	2.94090E-03	7.27000E+00	1.00530E+00	2.59615E-03
5.67000E+00	1.00040E+00	2.45204E-03	1.01100E+01	1.00650E+00	2.76586E-03
1.07500E+01	1.00360E+00	2.09067E-03	1.10000E+00	9.97600E-01	5.23450E-03
2.42000E+00	9.93300E-01	4.63897E-03	1.56000E+00	9.94800E-01	4.04475E-03
2.42000E+00	9.95800E-01	4.66905E-03	2.71000E+00	9.97700E-01	2.66833E-03
2.42000E+00	9.95300E-01	4.63897E-03	3.79000E+00	9 98600E-01	3.05941E-03
2.98000E+00	9.95000E-01	3.96232E-03	5.14000E+00	9.99700E-01	3.84708E-03
2.98000E+00	9.96500E-01	3 96232E-03	5.58000E+00	9 99600E-01	4.34166E-03

```
  chi =  0 3889 (upper bound = 9.49). The data tests normal.

      Output from statistical treatment

  AOA(2) MIX full set Vm/Vf

   Number of data points (n)                          36
   Linear regression, k(X)                            0.9941 + ( 1.1733E-03)*X
   Confidence on fit (1-gamma) [input]                95.0%
   Confidence on proportion (alpha) [input]           95.0%
   Proportion of population falling above
   lower tolerance interval (rho) [input]             99.9%
   Minimum value of X                                   1.1000
   Maximum value of X                                  10.7500
   Average value of X                                   3.71972
   Average value of k                                  0.99848
   Minimum value of k                                  0.99220
   Variance of fit, s(k,X)^2                           7.8921E-06
   Within variance, s(w)^2                             1.6194E-05
   Pooled variance, s(p)^2                             2.4087E-05
   Pooled std. deviation, s(p)                         4.9078E-03
   C(alpha,rho)*s(p)                                   2.5437E-02
   student-t @ (n-2,1-gamma)                           1.69180E+00
   Confidence band width, W                            9.5203E-03
   Minimum margin of subcriticality, C*s(p)-W          1.5916E-02

   Upper subcritical limits  (  1.1000     <= X <=   10.750    )
```

```
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)          USL1 = 0.9346 + ( 1 1733E-03)*X (X <    5.0124   )
                                     = 0.9405                   (X >=   5.012)

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)  USL2 = 0.9687 + ( 1 1733E-03)*X (X <    5.0124   )
                                     = 0.9746                   (X >=   5.012)


USLs Evaluated Over Range of Parameter X:
**** ********* **** ***** ** ********* **

X:  1.10E+0  2.48E+0  3.86E+0  5.24E+0  6.61E+0  7.99E+0  9.37E+0  1.08E+1
    ---------------------------------------------------------------------------
USL-1:   0.9359   0.9375   0.9391   0.9405   0.9405   0.9405   0.9405   0.9405
USL-2:   0.9700   0.9716   0 9732   0.9746   0.9746   0.9746   0.9746   0.9746
    ---------------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A3–6 AOA(2) – k_{eff} versus Pu content as trending parameter – SCALE 4.4a on PC

```
uslstats  a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

  Input to statistical treatment from file toto.inp

Title· AOA(2) MIX full set PuO2

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  36
  Minimum value of closed band =   0.00
  Maximum value of closed band =   0.00
  Administrative margin        =   0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
2.04000E+00	9.94700E-01	5.93043E-03	3.01000E+00	9 96700E-01	3.96232E-03
2.04000E+00	9.95500E-01	4.53982E-03	3.01000E+00	9.98100E-01	4.06079E-03
2.04000E+00	1.00020E+00	2.78927E-03	3.01000E+00	9.98600E-01	4.04475E-03
2.04000E+00	1.00470E+00	1.80278E-03	3.01000E+00	9.98700E-01	4.04475E-03
2.04000E+00	1.00180E+00	1.93132E-03	3.01000E+00	9.99700E-01	5 13517E-03
2.04000E+00	1.00660E+00	2.08806E-03	3.01000E+00	1.00000E+00	5.13517E-03
6.60000E+00	9.92200E-01	7.15433E-03	4.00000E+00	9.95600E-01	2 21359E-03
6 60000E+00	9.95600E-01	5.78558E-03	4.00000E+00	9.93900E-01	2 40416E-03
6.60000E+00	9.95700E-01	5.77260E-03	4.00000E+00	1.00320E+00	2.52982E-03
6.60000E+00	9.94200E-01	5.26673E-03	4.00000E+00	1.00200E+00	2.02485E-03
6.60000E+00	9.98000E-01	2.94090E-03	4.00000E+00	1.00530E+00	2.59615E-03
6.60000E+00	1.00040E+00	2.45204E-03	4.00000E+00	1.00650E+00	2.76586E-03
6.60000E+00	1.00360E+00	2.09067E-03	1.50000E+00	9.97600E-01	5.23450E-03
3.01000E+00	9.93300E-01	4.63897E-03	1.50000E+00	9.94800E-01	4.04475E-03
3.01000E+00	9.95800E-01	4.66905E-03	1.50000E+00	9.97700E-01	2.66833E-03
3.01000E+00	9 95300E-01	4.63897E-03	1.50000E+00	9.98600E-01	3.05941E-03
3.01000E+00	9.95000E-01	3.96232E-03	1.50000E+00	9.99700E-01	3.84708E-03
3.01000E+00	9.96500E-01	3.96232E-03	1 50000E+00	9.99600E-01	4.34166E-03

```
  chi =  0.3889 (upper bound = 9.49). The data tests normal.


       Output from statistical treatment

  AOA(2) MIX full set PuO2

   Number of data points (n)                          36
   Linear regression, k(X)                            0.9994 + (-2.5117E-04)*X
   Confidence on fit (1-gamma) [input]                95.0%
   Confidence on proportion (alpha) [input]           95.0%
   Proportion of population falling above
   lower tolerance interval (rho) [input]             99 9%
   Minimum value of X                                    1.5000
   Maximum value of X                                    6.6000
   Average value of X                                    3.45972
   Average value of k                                  0.99848
   Minimum value of k                                  0.99220
   Variance of fit, s(k,X)^2                          1.4666E-05
   Within variance, s(w)^2                            1.6194E-05
   Pooled variance, s(p)^2                            3 0861E-05
   Pooled std. deviation, s(p)                        5.5552E-03
   C(alpha,rho)*s(p)                                  2.6473E-02
   student-t @ (n-2,1-gamma)                          1.69180E+00
   Confidence band width, W                           9.9417E-03
   Minimum margin of subcriticality, C*s(p)-W         1 6531E-02

   Upper subcritical limits: (  1.5000     <= X <=   6.6000    )
   ***** *********** *******
```

```
USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0 9394 + (-2.5117E-04)*X

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9729 + (-2.5117E-04)*X


USLs Evaluated Over Range of Parameter X
**** ********* **** ***** ** ********* **

X·  1.50E+0  2.23E+0  2.96E+0  3.69E+0  4.41E+0  5.14E+0  5.87E+0  6.60E+0
    ---------------------------------------------------------------------
USL-1   0.9390   0.9389   0.9387   0.9385   0.9383   0.9381   0.9379   0.9378
USL-2·  0.9725   0.9723   0.9721   0.9720   0.9718   0.9716   0.9714   0 9712
    ---------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

ATTACHMENT NUMBER 4

OUTPUT LISTING OF USLSTATS V1.0 PROGRAM

FOR SUN PLATFORM

Figure A4–1 AOA(1) – k_{eff} versus EALF as trending parameter – SCALE 4.4 on Sun

```
uslstats· a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

  Input to statistical treatment from file toto.inp

Title: Test2 case data (no data supplied by user)

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  191
  Minimum value of closed band =    0.00
  Maximum value of closed band =    0.00
  Administrative margin        =    0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
8.79000E-02	1.00910E+00	5.11957E-03	1.67000E-01	1.00910E+00	3.38379E-03
1.11000E-01	1 00980E+00	5.09902E-03	1.67000E-01	1.00820E+00	3.38379E-03
1.35000E-01	1 01090E+00	5.11957E-03	1.66000E-01	1.01030E+00	3.32415E-03
1.51000E-01	1.00490E+00	5.11957E-03	1.69000E-01	1.00980E+00	4.41475E-03
1.59000E-01	1 00860E+00	5.09902E-03	1.68000E-01	1.00880E+00	4.41475E-03
3.48000E-01	1.00860E+00	5.11957E-03	1.67000E-01	1.00810E+00	4.41475E-03
7.12000E-02	1.00820E+00	4.82701E-03	1.66000E-01	1.00820E+00	4.41475E-03
7.29000E-02	1 00780E+00	4.82701E-03	1.67000E-01	1.00870E+00	4.46430E-03
7.78000E-02	1.00730E+00	4 82701E-03	1.68000E-01	1.01020E+00	4.39318E-03
8.15000E-02	1.00970E+00	4 82701E-03	1.68000E-01	1.00870E+00	4.41475E-03
8.51000E-02	1.01270E+00	4.80521E-03	1.67000E-01	1.00780E+00	4.41475E-03
9.29000E-02	1.00860E+00	4.82701E-03	1.67000E-01	1.00730E+00	4.41475E-03
1.00000E-01	1.01090E+00	4.82701E-03	1.67000E-01	1.00690E+00	4.43847E-03
5.84000E-02	1.00730E+00	4.78539E-03	1.67000E-01	1.00760E+00	4.43847E-03
5.96000E-02	1.00700E+00	4 80521E-03	1.68000E-01	1.01020E+00	4.46430E-03
6.18000E-02	1.00950E+00	4.78539E-03	1.68000E-01	1.00620E+00	4.43847E-03
6.27000E-02	1.00920E+00	4 80521E-03	1.67000E-01	1 00530E+00	4.43847E-03
6.54000E-02	1.01100E+00	4.80521E-03	1.67000E-01	1.00770E+00	4.41475E-03
6.94000E-02	1.01030E+00	4.85077E-03	1.67000E-01	1.00760E+00	4.41475E-03
5.91000E-02	1.01130E+00	4.82701E-03	1.67000E-01	1.00820E+00	4.46430E-03
6.01000E-02	1.00860E+00	4 80521E-03	1.69000E-01	1.00770E+00	4.41475E-03
5.34000E-02	1.00900E+00	4.93356E-03	1.68000E-01	1 00470E+00	4.41475E-03
5.37000E-02	1.00190E+00	4 87647E-03	1.68000E-01	1.00680E+00	4.41475E-03
5.48000E-02	1.00730E+00	4 93356E-03	1.68000E-01	1.00560E+00	4.43847E-03
5.60000E-02	1.00430E+00	4.87647E-03	1.67000E-01	1 00630E+00	4.39318E-03
5.46000E-02	1.00250E+00	4.87647E-03	1.67000E-01	1 00620E+00	4.41475E-03
5.49000E-02	1.00440E+00	4.93356E-03	2.37000E-01	1 01190E+00	3.92938E-03
5.59000E-02	1.01030E+00	4.93356E-03	2.37000E-01	1.01070E+00	3.92938E-03
5.65000E-02	1.00690E+00	4.87647E-03	2.36000E-01	1.00960E+00	3.92938E-03
5.87000E-02	1.00380E+00	4.90408E-03	2.36000E-01	1.00900E+00	3.98497E-03
6.32000E-02	1.00490E+00	4.96488E-03	2.36000E-01	1.00970E+00	3.92938E-03
6.85000E-02	1.00590E+00	4.87647E-03	2.36000E-01	1.00820E+00	3.95601E-03
5.59000E-02	1.00700E+00	4.90408E-03	2.38000E-01	1.01260E+00	4.80521E-03
5.56000E-02	1.00560E+00	4.85077E-03	2.38000E-01	1.00730E+00	4.82701E-03
5.56000E-02	1.00620E+00	4.93356E-03	2.36000E-01	1.01070E+00	4.80521E-03
5.66000E-02	1.00700E+00	4.90408E-03	2.36000E-01	1.00980E+00	4.82701E-03
5.77000E-02	1.00920E+00	4.85077E-03	2.38000E-01	1.00630E+00	4.85077E-03
6.01000E-02	1.00970E+00	4.90408E-03	2.38000E-01	1.00470E+00	4.82701E-03
6.30000E-02	1.01140E+00	4.87647E-03	2.37000E-01	1.00910E+00	4.80521E-03
6.61000E-02	1.00990E+00	4.93356E-03	2.35000E-01	1.01080E+00	4.82701E-03
6.93000E-02	1.00660E+00	4.85077E-03	2.38000E-01	1.01070E+00	4.80521E-03
5.66000E-02	1.00370E+00	4.87647E-03	2.38000E-01	1.00850E+00	4.82701E-03
5.80000E-02	1.00440E+00	4.87647E-03	2.37000E-01	1.00910E+00	4.87647E-03
5.24000E-02	1.00650E+00	3.59027E-03	2.38000E-01	1.00740E+00	4.43847E-03
5.34000E-02	1.00770E+00	3.59027E-03	2.37000E-01	1.00970E+00	4.41475E-03
5.52000E-02	1.00810E+00	3.59027E-03	2.36000E-01	1.00930E+00	4.46430E-03
6.48000E-02	1.01400E+00	3.44819E-03	2.37000E-01	1.00970E+00	4.43847E-03
7.85000E-02	1.01510E+00	4.17612E-03	1.68000E-01	1.00870E+00	3.98497E-03

7.94000E-02	1.02330E+00	4.12311E-03	1.67000E-01	1.00870E+00	3.98497E-03
8.02000E-02	1.02480E+00	4.14849E-03	1.67000E-01	1.01090E+00	3.95601E-03
6.03000E-02	1.02680E+00	3.04631E-03	1.67000E-01	1.01030E+00	3 92938E-03
5.71000E-02	1.02320E+00	3.04631E-03	1.65000E-01	1.00920E+00	3 51141E-03
8.73000E-02	1.00070E+00	4.17612E-03	1.66000E-01	1.00930E+00	3.51141E-03
5.51000E-01	1.00600E+00	6.21691E-03	1.67000E-01	1.01010E+00	3.51141E-03
7.52000E-02	1.03200E+00	3.86005E-03	1.67000E-01	1.00830E+00	3.95601E-03
6.62000E-02	1.02680E+00	3.28938E-03	1.67000E-01	1.00940E+00	3.98497E-03
9.94000E-02	1.02260E+00	4.30116E-03	1.67000E-01	1.00760E+00	3.98497E-03
7.68000E-02	1.02810E+00	4.30116E-03	1.67000E-01	1.00890E+00	3.95601E-03
1.08000E-01	1.00670E+00	4.39659E-03	1.67000E-01	1.00890E+00	3.92938E-03
7.46000E-02	1.01670E+00	4.27200E-03	1.67000E-01	1.00820E+00	3 95601E-03
6.53000E-02	1.01980E+00	3.54683E-03	1.67000E-01	1.00880E+00	3.98497E-03
7.95000E-02	1.01770E+00	4.14849E-03	1.67000E-01	1.01030E+00	3.95601E-03
8.01000E-02	1.02480E+00	4.17612E-03	1.67000E-01	1.00960E+00	3.95601E-03
6.05000E-02	1.02280E+00	3.04631E-03	1.67000E-01	1.01080E+00	4.01622E-03
5.74000E-02	1.02040E+00	3.00832E-03	1.67000E-01	1.00760E+00	3.92938E-03
8.60000E-02	1.00260E+00	4.20595E-03	1.67000E-01	1.00950E+00	3.95601E-03
5.20000E-01	9.97600E-01	6.28172E-03	1.67000E-01	1.00830E+00	3.95601E-03
7.73000E-02	1.02410E+00	3.86005E-03	1.67000E-01	1.01180E+00	3.98497E-03
6.68000E-02	1.01830E+00	3.32415E-03	1.67000E-01	1.00850E+00	3.98497E-03
9 96000E-02	1.02100E+00	4.34166E-03	1.67000E-01	1.01120E+00	3.95601E-03
7.93000E-02	1.01940E+00	4.33244E-03	1.67000E-01	1.00680E+00	3.95601E-03
1.47000E-01	1.01280E+00	4.42719E-03	1.67000E-01	1.00840E+00	3.95601E-03
1.16000E-01	1.00710E+00	4.42719E-03	6.57000E-02	1.00880E+00	6.02080E-03
8.03000E-02	1.02130E+00	4.30116E-03	6.47000E-02	1.01130E+00	6.08769E-03
7.50000E-02	1.01720E+00	4.33244E-03	5.89000E-02	1.00590E+00	6.02080E-03
6.36000E-02	1.01380E+00	5.36004E-03	7.63000E-02	1.00600E+00	6.06383E-03
5.20000E-02	9.99300E-01	5.29528E-03	7.93000E-02	1.00630E+00	6.04152E-03
6.47000E-02	1.02010E+00	5.29528E-03	6.04000E-02	1.00210E+00	6.04152E-03
5.29000E-02	1.00510E+00	5.27731E-03	1.06000E-01	1.00960E+00	6.06383E-03
6.70000E-02	1.02150E+00	5.29528E-03	7.58000E-02	1.00240E+00	6.04152E-03
5 29000E-02	1.00070E+00	5.29528E-03	6.48000E-02	1.01000E+00	6.08769E-03
6.78000E-02	1.01570E+00	5.27731E-03	5.85000E-02	1.00780E+00	6.02080E-03
5.41000E-02	9.99000E-01	5.27731E-03	7.59000E-02	1.00650E+00	6.06383E-03
7.55000E-02	1.00980E+00	5.29528E-03	7.92000E-02	1.00550E+00	6.04152E-03
5.56000E-02	1.00890E+00	5.29528E-03	7.60000E-02	1.00050E+00	6.06383E-03
5.93000E-02	1.00560E+00	5.27731E-03	1.07000E-01	1.00040E+00	6.08769E-03
5.40000E-02	1.00450E+00	5.27731E-03	7.87000E-02	1.01500E+00	3.92046E-03
1.68000E-01	1.00900E+00	3.35261E-03	7.88000E-02	1.01550E+00	3.92046E-03
1.67000E-01	1.00790E+00	3.38379E-03	7.91000E-02	1.01600E+00	3.92046E-03
1.67000E-01	1.00910E+00	3.38379E-03	7.97000E-02	1.01610E+00	3.92046E-03
1.67000E-01	1.00860E+00	3.35261E-03	8.02000E-02	1.01210E+00	3.92046E-03
1.67000E-01	1.00900E+00	3.38379E-03	8.05000E-02	1.00970E+00	3.92046E-03
1 67000E-01	1.00770E+00	3.38379E-03	8.82000E-02	9.99600E-01	5.22398E-03
1.68000E-01	1.00990E+00	3.41760E-03	8.89000E-02	9.97400E-01	5.22398E-03
1.67000E-01	1.00810E+00	3.38379E-03	8.90000E-02	9.96800E-01	5.11566E-03
1 68000E-01	1.00800E+00	3.32415E-03			

chi = 69.1309 (upper bound = 9 49). The data tests NOT normal

Output from statistical treatment

Test2 case data (no data supplied by user)

Number of data points (n)	191
Linear regression, k(X)	1 0113 + (-1.2867E-02)*X
Confidence on fit (1-gamma) [input]	95.0%
Confidence on proportion (alpha) [input]	95.0%
Proportion of population falling above lower tolerance interval (rho) [input]	99.9%
Minimum value of X	0.0520
Maximum value of X	0.5510
Average value of X	0 12713
Average value of k	1.00963
Minimum value of k	0.99680
Variance of fit, s(k,X)^2	3.2416E-05
Within variance, s(w)^2	2.0902E-05
Pooled variance, s(p)^2	5.3318E-05
Pooled std. deviation, s(p)	7.3019E-03
C(alpha,rho)*s(p)	4.1941E-02
student-t @ (n-2,1-gamma)	1.64500E+00
Confidence band width, W	1.2996E-02
Minimum margin of subcriticality, C*s(p)-W	2.8945E-02

Upper subcritical limits: (5 20000E-02 <= X <= 0.55100)
***** ********** *******

```
USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0.9370 ( 5.20000E-2< X < 0.55100   )

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9581 ( 5.20000E-2< X < 0.55100   )


USLs Evaluated Over Range of Parameter X:
**** ********* **** ***** ** ********* **

X:  5.20E-2  1.23E-1  1.95E-1  2.66E-1  3.37E-1  4.08E-1  4.80E-1  5.51E-1
    ---------------------------------------------------------------------
USL-1:   0.9370   0.9370   0 9370   0.9370   0.9370   0.9370   0.9370   0.9370
USL-2:   0.9581   0.9581   0 9581   0.9581   0.9581   0.9581   0.9581   0.9581
    ---------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A4–2 AOA(1) – k_{eff} versus H/Pu as trending parameter – SCALE 4.4 on Sun

```
uslstats: a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

  Input to statistical treatment from file:toto.inp

Title: Test2 case data (no data supplied by user)

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  191
  Minimum value of closed band =    0.00
  Maximum value of closed band =    0.00
  Administrative margin        =    0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
3.52910E+02	1 00910E+00	5.11957E-03	2.10180E+02	1.00910E+00	3.38379E-03
2.58050E+02	1 00980E+00	5.09902E-03	2.10180E+02	1.00820E+00	3.38379E-03
2.05140E+02	1 01090E+00	5.11957E-03	2 10180E+02	1.01030E+00	3.32415E-03
1.80970E+02	1.00490E+00	5.11957E-03	2.10180E+02	1.00980E+00	4.41475E-03
1.71210E+02	1 00860E+00	5.09902E-03	2.10180E+02	1.00880E+00	4.41475E-03
8.66600E+01	1.00860E+00	5.11957E-03	2.10180E+02	1.00810E+00	4.41475E-03
5.07980E+02	1.00820E+00	4.82701E-03	2.10180E+02	1.00820E+00	4.41475E-03
4.89180E+02	1.00780E+00	4.82701E-03	2.10180E+02	1.00870E+00	4.46430E-03
4.37280E+02	1.00730E+00	4.82701E-03	2.10180E+02	1.01020E+00	4.39318E-03
4.07450E+02	1.00970E+00	4.82701E-03	2.10180E+02	1.00870E+00	4.41475E-03
3.80570E+02	1.01270E+00	4.80521E-03	2.10180E+02	1.00780E+00	4.41475E-03
3.33540E+02	1.00860E+00	4.82701E-03	2.10180E+02	1.00730E+00	4.41475E-03
2.99260E+02	1.01090E+00	4.82701E-03	2.10180E+02	1.00690E+00	4.43847E-03
7.74150E+02	1.00730E+00	4.78539E-03	2.10180E+02	1.00760E+00	4.43847E-03
7.42710E+02	1.00700E+00	4.80521E-03	2.10180E+02	1.01020E+00	4.46430E-03
6.77170E+02	1.00950E+00	4 78539E-03	2.10180E+02	1.00620E+00	4.43847E-03
6.60550E+02	1.00920E+00	4 80521E-03	2.10180E+02	1.00530E+00	4.43847E-03
6.07170E+02	1.01100E+00	4.80521E-03	2.10180E+02	1.00770E+00	4.41475E-03
5.45330E+02	1.01030E+00	4.85077E-03	2.10180E+02	1.00760E+00	4.41475E-03
7.14830E+02	1.01130E+00	4.82701E-03	2.10180E+02	1.00820E+00	4.46430E-03
6.92120E+02	1.00860E+00	4.80521E-03	2.10180E+02	1.00770E+00	4.41475E-03
9.81670E+02	1.00900E+00	4.93356E-03	2.10180E+02	1.00470E+00	4.41475E-03
9.71630E+02	1.00190E+00	4.87647E-03	2.10180E+02	1.00680E+00	4.41475E-03
9.29600E+02	1.00730E+00	4.93356E-03	2.10180E+02	1.00560E+00	4.43847E-03
8.84120E+02	1.00430E+00	4.87647E-03	2.10180E+02	1.00630E+00	4.39318E-03
9.25520E+02	1.00250E+00	4.87647E-03	2.10180E+02	1.00620E+00	4.41475E-03
8.98580E+02	1.00440E+00	4.93356E-03	1.55210E+02	1.01190E+00	3.92938E-03
8.64010E+02	1.01030E+00	4.93356E-03	1.55270E+02	1.01070E+00	3.92938E-03
8.41980E+02	1.00690E+00	4.87647E-03	1.55270E+02	1.00960E+00	3.92938E-03
7.80210E+02	1.00380E+00	4.90408E-03	1.55270E+02	1.00900E+00	3.98497E-03
6.67980E+02	1.00490E+00	4.96488E-03	1.55270E+02	1.00970E+00	3.92938E-03
5.73340E+02	1.00590E+00	4.87647E-03	1.55270E+02	1.00820E+00	3.95601E-03
8.65010E+02	1.00700E+00	4.90408E-03	1.55270E+02	1.01260E+00	4.80521E-03
8.72210E+02	1.00560E+00	4.85077E-03	1.55270E+02	1.00730E+00	4.82701E-03
8.66360E+02	1.00620E+00	4.93356E-03	1.55270E+02	1.01070E+00	4.80521E-03
8.32710E+02	1.00700E+00	4.90408E-03	1.55270E+02	1.00980E+00	4.82701E-03
8.00710E+02	1.00920E+00	4.85077E-03	1.55270E+02	1.00630E+00	4.85077E-03
7.34370E+02	1.00970E+00	4.90408E-03	1.55270E+02	1.00470E+00	4.82701E-03
6.66080E+02	1.01140E+00	4.87647E-03	1.55270E+02	1.00910E+00	4.80521E-03
6 07890E+02	1.00990E+00	4.93356E-03	1 55270E+02	1.01080E+00	4.82701E-03
5.57170E+02	1.00660E+00	4.85077E-03	1.55270E+02	1.01070E+00	4.80521E-03
8.30640E+02	1.00370E+00	4.87647E-03	1.55270E+02	1.00850E+00	4.82701E-03
7.88950E+02	1.00440E+00	4.87647E-03	1 55270E+02	1.00910E+00	4.87647E-03
1.02816E+03	1.00650E+00	3.59027E-03	1.55270E+02	1.00740E+00	4.43847E-03
9.86180E+02	1 00770E+00	3.59027E-03	1.55270E+02	1.00970E+00	4 41475E-03
9.10900E+02	1.00810E+00	3.59027E-03	1.55270E+02	1.00930E+00	4.46430E-03
6.83880E+02	1 01400E+00	3.44819E-03	1.55270E+02	1.00970E+00	4 43847E-03
4.95930E+02	1 01510E+00	4.17612E-03	2.10180E+02	1.00870E+00	3.98497E-03
4.88550E+02	1 02330E+00	4.12311E-03	2.10170E+02	1.00870E+00	3 98497E-03

4.86150E+02	1.02480E+00	4.14849E-03	2.10170E+02	1.01090E+00	3.95601E-03
7.82400E+02	1.02680E+00	3.04631E-03	2.10170E+02	1.01030E+00	3.92938E-03
8.67100E+02	1.02320E+00	3.04631E-03	2.10170E+02	1.00920E+00	3.51141E-03
4.54500E+02	1.00070E+00	4.17612E-03	2.10170E+02	1.00930E+00	3.51141E-03
8.50300E+01	1.00600E+00	6.21691E-03	2.10170E+02	1.01010E+00	3.51141E-03
5.21450E+02	1.03200E+00	3.86005E-03	2.10180E+02	1.00830E+00	3.95601E-03
6 50830E+02	1.02680E+00	3.28938E-03	2.10180E+02	1.00940E+00	3.98497E-03
3.44020E+02	1.02260E+00	4.30116E-03	2.10180E+02	1.00760E+00	3.98497E-03
4.99920E+02	1.02810E+00	4.30116E-03	2.10180E+02	1.00890E+00	3.95601E-03
3.28020E+02	1.00670E+00	4.39659E-03	2.10180E+02	1.00890E+00	3.92938E-03
5.38180E+02	1.01670E+00	4.27200E-03	2.10180E+02	1.00820E+00	3.95601E-03
6.73070E+02	1.01980E+00	3.54683E-03	2.10180E+02	1.00880E+00	3.98497E-03
4.88550E+02	1.01770E+00	4.14849E-03	2.10180E+02	1.01030E+00	3.95601E-03
4.86150E+02	1.02480E+00	4.17612E-03	2.10180E+02	1.00960E+00	3.95601E-03
7 76810E+02	1.02280E+00	3.04631E-03	2.10180E+02	1.01080E+00	4.01622E-03
8.56600E+02	1.02040E+00	3.00832E-03	2.10180E+02	1.00760E+00	3.92938E-03
4.62990E+02	1.00260E+00	4.20595E-03	2.10180E+02	1.00950E+00	3.95601E-03
8.84300E+01	9.97600E-01	6.28172E-03	2.10180E+02	1.00830E+00	3.95601E-03
4 96980E+02	1.02410E+00	3.86005E-03	2.10180E+02	1.01180E+00	3.98497E-03
6.39340E+02	1.01830E+00	3.32415E-03	2.10180E+02	1.00850E+00	3.98497E-03
3.44020E+02	1.02100E+00	4.34166E-03	2.10180E+02	1.01120E+00	3.95601E-03
4.74900E+02	1.01940E+00	4.33244E-03	2.10180E+02	1.00680E+00	3.95601E-03
2.32010E+02	1.01280E+00	4.42719E-03	2.10180E+02	1.00840E+00	3.95601E-03
3.01120E+02	1.00710E+00	4.42719E-03	6.03570E+02	1.00880E+00	6.02080E-03
4.75390E+02	1.02130E+00	4.30116E-03	6.21120E+02	1.01130E+00	6.08769E-03
5.31210E+02	1.01720E+00	4.33244E-03	7.47180E+02	1.00590E+00	6.02080E-03
7.33000E+02	1.01380E+00	5.36004E-03	4.62510E+02	1.00600E+00	6.06383E-03
1.15729E+03	9.99300E-01	5.29528E-03	4.51850E+02	1.00630E+00	6.04152E-03
7.05450E+02	1.02010E+00	5.29528E-03	7.23850E+02	1.00210E+00	6.04152E-03
1.10319E+03	1.00510E+00	5.27731E-03	3.42960E+02	1.00960E+00	6.06383E-03
6.62770E+02	1.02150E+00	5.29528E-03	5 40110E+02	1.00240E+00	6.04152E-03
1.10978E+03	1.00070E+00	5.29528E-03	6.17240E+02	1.01000E+00	6.08769E-03
6.53420E+02	1.01570E+00	5.27731E-03	7.53990E+02	1.00780E+00	6.02080E-03
1.05374E+03	9.99000E-01	5.27731E-03	4 65800E+02	1.00650E+00	6.06383E-03
5.50660E+02	1 00980E+00	5.29528E-03	4.51850E+02	1.00550E+00	6.04152E-03
9.95410E+02	1.00890E+00	5 29528E-03	5.40110E+02	1.00050E+00	6.06383E-03
8.70370E+02	1.00560E+00	5.27731E-03	3 41170E+02	1.00040E+00	6.08769E-03
1.05643E+03	1.00450E+00	5.27731E-03	4 24340E+02	1.01500E+00	3.92046E-03
2.10180E+02	1.00900E+00	3 35261E-03	4.24340E+02	1.01550E+00	3.92046E-03
2.10180E+02	1.00790E+00	3 38379E-03	4.24340E+02	1.01600E+00	3.92046E-03
2.10180E+02	1.00910E+00	3 38379E-03	4.24340E+02	1.01610E+00	3.92046E-03
2.10180E+02	1.00860E+00	3.35261E-03	4.24340E+02	1.01210E+00	3.92046E-03
2.10180E+02	1.00900E+00	3.38379E-03	4.24340E+02	1.00970E+00	3.92046E-03
2.10180E+02	1.00770E+00	3.38379E-03	4.30260E+02	9.99600E-01	5.22398E-03
2.10180E+02	1.00990E+00	3.41760E-03	4.25560E+02	9.97400E-01	5.22398E-03
2.10180E+02	1.00810E+00	3.38379E-03	4.25270E+02	9.96800E-01	5.11566E-03
2.10180E+02	1.00800E+00	3.32415E-03			

chi = 69.1309 (upper bound = 9.49). The data tests NOT normal

Output from statistical treatment

Test2 case data (no data supplied by user)

Number of data points (n)	191
Linear regression, k(X)	1.0096 + (1.7495E-07)*X
Confidence on fit (1-gamma) [input]	95.0%
Confidence on proportion (alpha) [input]	95.0%
Proportion of population falling above lower tolerance interval (rho) [input]	99.9%
Minimum value of X	85.0300
Maximum value of X	1157.2900
Average value of X	433.28293
Average value of k	1.00963
Minimum value of k	0.99680
Variance of fit, s(k,X)^2	3.3366E-05
Within variance, s(w)^2	2.0902E-05
Pooled variance, s(p)^2	5.4268E-05
Pooled std. deviation, s(p)	7.3667E-03
C(alpha,rho)*s(p)	3.9294E-02
student-t @ (n-2,1-gamma)	1.64500E+00
Confidence band width, W	1.2368E-02
Minimum margin of subcriticality, C*s(p)-W	2.6926E-02

Upper subcritical limits: (85.030 <= X <= 1157.3)
***** ********** *******

USL Method 1 (Confidence Band with

```
Administrative Margin)            USL1 = 0.9376 (  85.030   < X <  1157.3   )

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9607 (  85.030   < X <  1157.3   )


USLs Evaluated Over Range of Parameter X
**** ********* **** ***** ** ********* **

X.  8 50E+1  2 38E+2  3.91E+2  5.45E+2  6.98E+2  8.51E+2  1.00E+3  1.16E+3
    ---------------------------------------------------------------------
USL-1:   0.9376   0.9376   0.9376   0.9376   0.9376   0.9376   0 9376   0.9376
USL-2    0.9607   0.9607   0.9607   0.9607   0.9607   0.9607   0.9607   0.9607
    ---------------------------------------------------------------------

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                                Finis
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Figure A4–3 AOA(1) – k_{eff} versus ^{240}Pu content as trending parameter – SCALE 4.4 on Sun

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          uslstats· a utility to calculate upper subcritical
                    limits for criticality safety applications

*****************************************************************************
                    Version 1 3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

   Input to statistical treatment from file:toto inp

Title  AOA(1) SUN Pu240

   Proportion of the population = .999
   Confidence of fit            = .950
   Confidence on proportion     = .950
   Number of observations       =  46
   Minimum value of closed band =    0.00
   Maximum value of closed band =    0.00
   Administrative margin        =    0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
4.67000E+00	1.00910E+00	5.11957E-03	5.40000E-01	1.00730E+00	4.93356E-03
4.67000E+00	1.00980E+00	5.09902E-03	5.40000E-01	1.00430E+00	4.87647E-03
4.67000E+00	1.01090E+00	5.11957E-03	1.76000E+00	1 00250E+00	4.87647E-03
4.67000E+00	1.00490E+00	5.11957E-03	3.12000E+00	1.00440E+00	4.93356E-03
4.67000E+00	1.00860E+00	5.09902E-03	3.12000E+00	1.01030E+00	4.93356E-03
4.67000E+00	1.00860E+00	5.11957E-03	3.12000E+00	1.00690E+00	4.87647E-03
3 12000E+00	1.00820E+00	4.82701E-03	3.12000E+00	1.00380E+00	4.90408E-03
3 12000E+00	1.00780E+00	4.82701E-03	3.12000E+00	1.00490E+00	4.96488E-03
3 12000E+00	1.00730E+00	4.82701E-03	3.12000E+00	1.00590E+00	4 87647E-03
3.12000E+00	1.00970E+00	4.82701E-03	3.12000E+00	1.00700E+00	4.90408E-03
3 12000E+00	1.01270E+00	4.80521E-03	3 43000E+00	1.00560E+00	4.85077E-03
3.12000E+00	1.00860E+00	4.82701E-03	4 05000E+00	1.00620E+00	4.93356E-03
3.12000E+00	1.01090E+00	4.82701E-03	4.05000E+00	1.00700E+00	4.90408E-03
1.76000E+00	1.00730E+00	4.78539E-03	4.05000E+00	1.00920E+00	4.85077E-03
1.76000E+00	1.00700E+00	4.80521E-03	4.05000E+00	1.00970E+00	4.90408E-03
3.12000E+00	1.00950E+00	4.78539E-03	4.05000E+00	1.01140E+00	4.87647E-03
3.12000E+00	1.00920E+00	4.80521E-03	4.05000E+00	1.00990E+00	4.93356E-03
3.12000E+00	1.01100E+00	4 80521E-03	4.05000E+00	1.00660E+00	4.85077E-03
3.12000E+00	1.01030E+00	4.85077E-03	4.40000E+00	1.00370E+00	4.87647E-03
3.12000E+00	1.01130E+00	4.82701E-03	4.40000E+00	1 00440E+00	4.87647E-03
3.12000E+00	1.00860E+00	4.80521E-03	3.12000E+00	1.00650E+00	3.59027E-03
5.40000E-01	1.00900E+00	4.93356E-03	3.12000E+00	1 00770E+00	3.59027E-03
5.40000E-01	1.00190E+00	4.87647E-03	3.12000E+00	1.00810E+00	3.59027E-03

```
   chi =  1 6087 (upper bound = 9.49). The data tests normal.


        Output from statistical treatment

   AOA(1) SUN Pu240

    Number of data points (n)                        46
    Linear regression, k(X)                          1.0057 + ( 6 1803E-04)*X
    Confidence on fit (1-gamma) [input]              95.0%
    Confidence on proportion (alpha) [input]         95.0%
    Proportion of population falling above
    lower tolerance interval (rho) [input]           99.9%
    Minimum value of X                                 0.5400
    Maximum value of X                                 4.6700
    Average value of X                                 3.21304
    Average value of k                               1.00773
    Minimum value of k                               1.00190
    Variance of fit, s(k,X)^2                        5.9911E-06
    Within variance, s(w)^2                          2.3285E-05
    Pooled variance, s(p)^2                          2.9276E-05
    Pooled std. deviation, s(p)                      5.4107E-03
    C(alpha,rho)*s(p)                                2.5367E-02
```

```
student-t @ (n-2,1-gamma)                          1.68140E+00
Confidence band width, W                           9.7570E-03
Minimum margin of subcriticality, C*s(p)-W         1.5610E-02

Upper subcritical limits: ( 0 54000     <= X <=   4.6700    )
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0.9402 ( 0.54000   < X <  4.6700   )

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9746 ( 0.54000   < X <  4.6700   )


USLs Evaluated Over Range of Parameter X.
**** ********* **** ***** ** ********* **

X    5.40E-1  1.13E+0  1.72E+0  2.31E+0  2.90E+0  3.49E+0  4.08E+0  4.67E+0
     ---------------------------------------------------------------------
USL-1·  0.9402   0.9402   0.9402   0.9402   0.9402   0.9402   0.9402   0.9402
USL-2:  0.9746   0.9746   0 9746   0.9746   0.9746   0.9746   0.9746   0.9746
     ---------------------------------------------------------------------

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                         Thus spake USLSTATS
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Figure A4–4 AOA(2) – k_{eff} versus EALF as trending parameter – SCALE 4.4 on Sun

```
          uslstats: a utility to calculate upper subcritical
                    limits for criticality safety applications

 ****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
 ****************************************************************************

  Input to statistical treatment from file:toto inp

Title: AOA(2) Mix full set EALF

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  36
  Minimum value of closed band =   0.00
  Maximum value of closed band =   0.00
  Administrative margin        =   0 05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
5.76000E-01	9.93100E-01	6.02080E-03	1.18000E-01	9.96600E-01	4.11096E-03
7.67000E-01	9.96000E-01	4.71275E-03	9.24000E-02	9.97900E-01	4.17612E-03
1.93000E-01	1.00020E+00	2.95466E-03	9.24000E-02	9.97900E-01	4.17612E-03
2.82000E-01	1.00570E+00	2.08087E-03	9 23000E-02	9.99500E-01	4.20595E-03
1.38000E-01	1.00180E+00	2.10950E-03	7.99000E-02	9.99800E-01	5 28867E-03
1.83000E-01	1.00580E+00	2 28254E-03	7.95000E-02	1.00000E+00	5.21728E-03
9.09000E-01	9.91100E-01	7.23771E-03	3.92000E-01	9.96300E-01	2.41868E-03
5 49000E-01	9.93900E-01	5.87562E-03	2.60000E-01	9.95600E-01	2.74591E-03
5.48000E-01	9.96400E-01	5.87562E-03	1.77000E-01	1.00410E+00	2.68328E-03
6.54000E-01	9.97100E-01	5.35616E-03	1.46000E-01	1.00330E+00	2.36009E-03
1.89000E-01	1.00130E+00	3.11431E-03	1.08000E-01	1.00520E+00	2.96816E-03
1 56000E-01	1.00110E+00	2.68561E-03	9.35000E-02	1.00690E+00	3.13847E-03
1 02000E-01	1.00220E+00	2.36027E-03	5.48000E-01	9.97700E-01	5.29528E-03
1.46000E-01	9.91600E-01	4.75395E-03	3.06000E-01	9.93400E-01	4.12311E-03
1.45000E-01	9.94000E-01	4.78017E-03	1.57000E-01	9.95100E-01	2.86356E-03
1.44000E-01	9.94400E-01	4.78017E-03	1.17000E-01	9.97900E-01	3.13209E-03
1.20000E-01	9.95600E-01	4.11096E-03	9 58000E-02	9.99600E-01	3.88330E-03
1.19000E-01	9 95200E-01	4.05216E-03	9 16000E-02	1.00040E+00	4.37379E-03

```
  WARNING *** the test for normal may be unreliable due to insufficient data.

  chi =  2.3333 (upper bound = 9.49). The data tests normal.


       Output from statistical treatment

  AOA(2) Mix full set EALF

   Number of data points (n)                          36
   Linear regression, k(X)                            1.0005 + (-8.4182E-03)*X
   Confidence on fit (1-gamma) [input]                95.0%
   Confidence on proportion (alpha) [input]           95.0%
   Proportion of population falling above
   lower tolerance interval (rho) [input]             99.9%
   Minimum value of X                                   0.0795
   Maximum value of X                                   0.9090
   Average value of X                                   0.24907
   Average value of k                                 0.99844
   Minimum value of k                                 0.99110
   Variance of fit, s(k,X)^2                          1.4297E-05
   Within variance, s(w)^2                            1.7282E-05
   Pooled variance, s(p)^2                            3.1579E-05
   Pooled std  deviation, s(p)                        5.6195E-03
   C(alpha,rho)*s(p)                                  2.8854E-02
   student-t @ (n-2,1-gamma)                          1.69180E+00
   Confidence band width, W                           1.0792E-02
```

```
Minimum margin of subcriticality, C*s(p)-W          1.8062E-02

Upper subcritical limits· ( 7.95000E-02 <= X <=  0.90900    )
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)              USL1 = 0.9397 + (-8.4182E-03)*X

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)     USL2 = 0.9717 + (-8.4182E-03)*X


USLs Evaluated Over Range of Parameter X
**** ********* **** ***** ** ********* **

X:  7.95E-2  1.98E-1  3.17E-1  4.35E-1  5.54E-1  6.72E-1  7.91E-1  9.09E-1
   ---------------------------------------------------------------------------
USL-1:   0.9391   0.9381   0.9371   0.9361   0.9351   0.9341   0.9331   0.9321
USL-2:   0.9710   0.9700   0.9690   0.9680   0.9670   0.9660   0.9650   0.9640
   ---------------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A4–5 AOA(2) – k_{eff} versus v^m/v^f as trending parameter – SCALE 4.4 on Sun

```
          uslstats· a utility to calculate upper subcritical
                    limits for criticality safety applications

*****************************************************************************
                    Version 1.3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

  Input to statistical treatment from file:toto.inp

Title· AOA(2) Mix full set Vm/Vf

  Proportion of the population = .999
  Confidence of fit            = .950
  Confidence on proportion     = .950
  Number of observations       =  36
  Minimum value of closed band =   0.00
  Maximum value of closed band =   0.00
  Administrative margin        =   0.05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
1.19000E+00	9.93100E-01	6 02080E-03	2.98000E+00	9.96600E-01	4.11096E-03
1.19000E+00	9.96000E-01	4.71275E-03	4.24000E+00	9.97900E-01	4.17612E-03
2.52000E+00	1.00020E+00	2.95466E-03	4.24000E+00	9.97900E-01	4.17612E-03
2.52000E+00	1.00570E+00	2.08087E-03	4.24000E+00	9.99500E-01	4.20595E-03
3.64000E+00	1.00180E+00	2 10950E-03	5 55000E+00	9.99800E-01	5.28867E-03
3.64000E+00	1.00580E+00	2.28254E-03	5 55000E+00	1.00000E+00	5.21728E-03
1.68000E+00	9.91100E-01	7.23771E-03	1.93000E+00	9.96300E-01	2.41868E-03
2.16000E+00	9.93900E-01	5.87562E-03	2 56000E+00	9.95600E-01	2.74591E-03
2.16000E+00	9.96400E-01	5 87562E-03	3 62000E+00	1.00410E+00	2.68328E-03
2.16000E+00	9.97100E-01	5 35616E-03	4 53000E+00	1.00330E+00	2.36009E-03
4.71000E+00	1.00130E+00	3 11431E-03	7 27000E+00	1.00520E+00	2.96816E-03
5.67000E+00	1.00110E+00	2.68561E-03	1.01100E+01	1.00690E+00	3.13847E-03
1.07500E+01	1.00220E+00	2.36027E-03	1.10000E+00	9.97700E-01	5.29528E-03
2.42000E+00	9.91600E-01	4.75395E-03	1.56000E+00	9.93400E-01	4.12311E-03
2.42000E+00	9.94000E-01	4.78017E-03	2.71000E+00	9.95100E-01	2.86356E-03
2.42000E+00	9.94400E-01	4.78017E-03	3.79000E+00	9.97900E-01	3.13209E-03
2.98000E+00	9.95600E-01	4.11096E-03	5.14000E+00	9 99600E-01	3.88330E-03
2.98000E+00	9.95200E-01	4.05216E-03	5 58000E+00	1.00040E+00	4.37379E-03

```
  WARNING *** the test for normal may be unreliable due to insufficient data.

  chi =  2.3333 (upper bound = 9 49). The data tests normal.


       Output from statistical treatment

  AOA(2) Mix full set Vm/Vf

   Number of data points (n)                        36
   Linear regression, k(X)                         0 9939 + ( 1.2243E-03)*X
   Confidence on fit (1-gamma) [input]              95.0%
   Confidence on proportion (alpha) [input]         95.0%
   Proportion of population falling above
   lower tolerance interval (rho) [input]           99 9%
   Minimum value of X                                 1.1000
   Maximum value of X                                10.7500
   Average value of X                                 3.71972
   Average value of k                               0.99844
   Minimum value of k                               0.99110
   Variance of fit, s(k,X)^2                       1.0185E-05
   Within variance, s(w)^2                         1.7282E-05
   Pooled variance, s(p)^2                         2.7467E-05
   Pooled std. deviation, s(p)                     5.2409E-03
   C(alpha,rho)*s(p)                               2.7163E-02
   student-t @ (n-2,1-gamma)                       1.69180E+00
   Confidence band width, W                        1.0166E-02
```

```
Minimum margin of subcriticality, C*s(p)-W          1 6997E-02

Upper subcritical limits  (  1.1000     <= X <=   10 750    )
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)            USL1 = 0.9337 + ( 1.2243E-03)*X (X <    4.9971   )
                                       = 0.9398                   (X >=   4 997)

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)   USL2 = 0.9667 + ( 1.2243E-03)*X (X <    4 9971   )
                                       = 0.9728                   (X >=   4.997)


USLs Evaluated Over Range of Parameter X:
**** ********* **** ***** ** ********* **

X·  1.10E+0  2.48E+0  3.86E+0  5 24E+0  6.61E+0  7.99E+0  9.37E+0  1.08E+1
    ---------------------------------------------------------------------
USL-1:   0.9351   0.9368   0.9384   0.9398   0.9398   0.9398   0.9398   0.9398
USL-2:   0 9681   0.9698   0.9714   0.9728   0.9728   0.9728   0.9728   0 9728
    ---------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

Figure A4–6 AOA(2) – k_{eff} versus Pu content as trending parameter – SCALE 4.4 on Sun

```
uslstats  a utility to calculate upper subcritical
          limits for criticality safety applications

*****************************************************************************
                    Version 1 3.7, May 18, 1999
                     Oak Ridge National Laboratory
*****************************************************************************

Input to statistical treatment from file toto.inp

Title· AOA(2) Mix full set Pu content

Proportion of the population = .999
Confidence of fit            = .950
Confidence on proportion     = .950
Number of observations       =  36
Minimum value of closed band =   0 00
Maximum value of closed band =   0.00
Administrative margin        =   0 05
```

independent variable - x	dependent variable - y	deviation in y	independent variable - x	dependent variable - y	deviation in y
2.04000E+00	9.93100E-01	6.02080E-03	3.01000E+00	9.96600E-01	4.11096E-03
2.04000E+00	9.96000E-01	4.71275E-03	3.01000E+00	9.97900E-01	4.17612E-03
2.04000E+00	1.00020E+00	2.95466E-03	3.01000E+00	9.97900E-01	4.17612E-03
2.04000E+00	1.00570E+00	2.08087E-03	3.01000E+00	9.99500E-01	4.20595E-03
2.04000E+00	1.00180E+00	2 10950E-03	3.01000E+00	9.99800E-01	5.28867E-03
2.04000E+00	1.00580E+00	2.28254E-03	3.01000E+00	1.00000E+00	5.21728E-03
6.60000E+00	9.91100E-01	7.23771E-03	4.00000E+00	9 96300E-01	2.41868E-03
6.60000E+00	9.93900E-01	5.87562E-03	4.00000E+00	9 95600E-01	2.74591E-03
6.60000E+00	9.96400E-01	5.87562E-03	4.00000E+00	1.00410E+00	2.68328E-03
6.60000E+00	9.97100E-01	5.35616E-03	4.00000E+00	1.00330E+00	2.36009E-03
6.60000E+00	1.00130E+00	3.11431E-03	4.00000E+00	1.00520E+00	2.96816E-03
6 60000E+00	1.00110E+00	2.68561E-03	4 00000E+00	1.00690E+00	3.13847E-03
6.60000E+00	1.00220E+00	2.36027E-03	1.50000E+00	9.97700E-01	5.29528E-03
3.01000E+00	9.91600E-01	4.75395E-03	1.50000E+00	9.93400E-01	4.12311E-03
3.01000E+00	9.94000E-01	4.78017E-03	1.50000E+00	9.95100E-01	2.86356E-03
3.01000E+00	9 94400E-01	4.78017E-03	1.50000E+00	9.97900E-01	3.13209E-03
3.01000E+00	9 95600E-01	4 11096E-03	1.50000E+00	9.99600E-01	3.88330E-03
3.01000E+00	9.95200E-01	4 05216E-03	1.50000E+00	1.00040E+00	4.37379E-03

```
WARNING *** the test for normal may be unreliable due to insufficient data

chi =  2 3333 (upper bound = 9.49). The data tests normal.


     Output from statistical treatment

AOA(2) Mix full set Pu content

Number of data points (n)                          36
Linear regression, k(X)                            0.9985 + (-2.3845E-05)*X
Confidence on fit (1-gamma) [input]                95.0%
Confidence on proportion (alpha) [input]           95.0%
Proportion of population falling above
lower tolerance interval (rho) [input]             99.9%
Minimum value of X                                    1.5000
Maximum value of X                                    6.6000
Average value of X                                    3.45972
Average value of k                                 0.99844
Minimum value of k                                 0.99110
Variance of fit, s(k,X)^2                          1.7777E-05
Within variance, s(w)^2                            1.7282E-05
Pooled variance, s(p)^2                            3.5059E-05
Pooled std. deviation, s(p)                        5.9210E-03
C(alpha,rho)*s(p)                                  2.8216E-02
student-t @ (n-2,1-gamma)                          1.69180E+00
Confidence band width, W                           1.0596E-02
```

```
Minimum margin of subcriticality, C*s(p)-W          1.7620E-02

Upper subcritical limits  (  1.5000     <= X <=   6.6000    )
***** *********** *******

USL Method 1 (Confidence Band with
Administrative Margin)              USL1 = 0 9379 + (-2 3845E-05)*X

USL Method 2 (Single-Sided Uniform
Width Closed Interval Approach)     USL2 = 0.9703 + (-2 3845E-05)*X


USLs Evaluated Over Range of Parameter X:
**** ********* **** ***** ** ********* **

X   1.50E+0  2.23E+0  2.96E+0  3.69E+0  4.41E+0  5.14E+0  5 87E+0  6.60E+0
    ---------------------------------------------------------------------
USL-1:   0.9379   0 9379   0.9379   0.9378   0.9378   0.9378   0.9378   0.9378
USL-2    0.9703   0 9702   0.9702   0.9702   0.9702   0.9702   0.9702   0.9701
    ---------------------------------------------------------------------

*****************************************************************************
                          Thus spake USLSTATS
                                Finis.
```

ATTACHMENT 5

BORATED CONCRETE REFLECTORS

ABSTRACT

This attachment presents validation results for the SCALE 4.4 CSAS26 (KENO VI) criticality analysis sequence and the 238 energy group cross-section library (238GROUPNDF5) applicable to borated concrete fixed neutron absorber materials. As noted in Section 3.2, borated concrete is used in reflector regions of several MFFF plutonium nitrate aqueous solution design applications. However, the validation presented in the body of the report includes no benchmark experiment data or results for plutonium nitrate solution systems that include borated concrete neutron absorber materials. This attachment presents benchmark experiment data and validation results for high enrichment uranium nitrate aqueous solution systems that includes borated concrete supplemental absorber materials. The validation results presented for high enrichment uranium nitrate solution systems indicate that the CSAS26 criticality analysis sequence and the 238GROUPNDF5 cross-section library produce comparable results for systems with and without borated concrete neutron absorber materials present. This conclusion supports the use of the USL-1 for AOA-1 presented in Section 6.1 of this validation report as an acceptance criterion for plutonium nitrate aqueous solution systems that include borated concrete supplemental neutron absorber materials.

INTRODUCTION

Some design applications in the MFFF involving plutonium nitrate (Pu-nitrate) aqueous solutions include consideration of a full range of possible pure water reflection conditions. For those applications, the benchmarks selected in Section 4.1 are directly applicable. Other MFFF Pu-nitrate solution design applications incorporate borated concrete as a neutron absorber for criticality control purposes. A review of technical literature, including the International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999), did not identify any Pu-nitrate solution benchmark experiments that included borated concrete or other boron containing neutron absorber materials. However, a number of uranium nitrate (U-nitrate) solution fissile medium experiments that include borated concrete, borated plaster, and borated water neutron absorber materials were identified. These experiments are evaluated using the SCALE 4.4 CSAS26 (KENO VI) criticality analysis sequence and the 238 energy group cross-section library (238GROUPNDF5). The results of this evaluation are used to demonstrate the applicability of the USL-1 acceptance criterion for AOA-1 presented in Section 6.1 of this validation report to Pu-nitrate systems incorporating borated concrete neutron absorber materials.

The appendix begins by providing a brief description of the high enrichment U-nitrate solution benchmark experiments and CSAS26/238GROUPNDF5 analyzed results. The results are then evaluated to accomplish the following:

1. Determine the bias, if any, between k_{eff} results obtained for experiments with borated concrete or borated plaster neutron absorbers and other similar experiments without these materials present,

2. Confirm the applicability of the U-nitrate experiment results to Pu-nitrate solution design applications, and

3. Determine the area(s) of applicability (AOA) encompassed by the borated concrete and borated plaster neutron absorber experiments evaluated and determine if any trends can be identified.

The approach taken to validate the CSAS26/238GROUPNDF5 criticality analysis methodology for application to Pu-nitrate systems incorporating borated concrete neutron absorber materials does not involve direct inclusion of the U-nitrate solution experiment data in the USL-1 determination. The approach involves a separate evaluation of the uranium-based data to demonstrate no significant method bias or uncertainty variations are observed when comparing results for systems that include borated concrete neutron absorber materials with results for systems that do not. The approach also demonstrates that the neutron absorption spectrum within the absorbing material is relatively insensitive to the source of the neutrons (e.g., U or Pu). This indirect approach is selected to avoid combining plutonium and uranium fissile medium benchmark experiment k_{eff} results in the USL-1 determination. Significant differences in method bias as a function of neutron energy spectra have been previously observed when comparing results for plutonium and uranium fissile systems (DeHart and Bowman 1994).

U-NITRATE SOLUTION EXPERIMENT DESCRIPTIONS AND ANALYZED RESULTS

The critical experiments designated as HEU-SOL-THERM-033 in the International Handbook of Evaluated Criticality Safety Benchmark Experiments are used in order to validate the CSAS26/238GROUPNDF5 code system for use in Pu-nitrate solution design applications involving borated concrete supplemental neutron absorber materials. The HEU-SOL-THERM-033 experiments were performed at the Rocky Flats Critical Mass Laboratory and involved nested annular steel tanks containing fissile material solution with various materials inserted as a "plug" in the central annulus region formed by the innermost annular tank. The tank system was situated inside a concrete enclosure. Materials inserted in the central region included air, boron-free water, borated water, boron-free concrete, borated concrete, and borated plaster. Critical heights of the highly enriched solutions were measured. Thirty-seven critical configurations were attempted during 12 experiment sets. Nine of the configurations were subcritical. Of the 28 critical configurations, 26 were judged acceptable for benchmark applications by the experiment evaluator and reviewers (Nuclear Energy Agency 1999).

All 26 HEU-SOL-THERM-033 critical experiments judged acceptable by the benchmark handbook evaluator and reviewers were analyzed using CSAS25 (238-Group ENDF/B-IV cross section library) for verification purposes. Verification results are reported in the handbook. CSAS26 input files were prepared and calculations performed using the 238GROUPNDF5 cross section set as well. The calculated k_{eff} results for the complete set of all 26 of the benchmark experiments are presented in Table 1. Also presented in Table 1 are estimated values for measured k_{eff} and experiment uncertainties reported in the handbook and results of statistical analysis performed on the calculated data. Calculated k_{eff} results and similar grouped statistical analysis results are presented in Tables 2 through 5 for the following subsets of experiments: (a) 15 experiments with no borated concrete or borated plaster, (b) 18 experiments with no boron-free concrete, (c) 19 experiments with boron-free concrete, borated concrete, or borated plaster, and (d) 11 experiments with borated concrete or borated plaster. A summary of the statistical results for the five sets of experiment results evaluated is provided in Table 6.

A review of the Table 6 results summary indicates that no significant difference in bias results for systems that include borated concrete neutron absorbers as compared to systems that do not when using CSAS26 and the 238GROUPNDF5 cross section library. For example, the evaluated variation in CSAS26 method bias indicated for benchmark experiment sets with and without borated concrete (i.e., Table 2 and 5 method bias values) is 0.0015. This variation is small compared to the level of uncertainty in the method bias accounted for in the determination of USL-1 in Section 6.1 of the report (i.e., 0.01). The results also indicate that the criticality analysis methodology tends to predict higher k_{eff} results for systems containing borated concrete than for systems without any concrete, though slightly less than for systems containing boron-free concrete. This observation provides additional rationale supporting the acceptability of extrapolating Section 6.1 Pu-nitrate solution validation results to MFFF design applications containing borated concrete.

EXPERIMENT SET APPLICABILITY TO PU-NITRATE SYSTEMS

The applicability of the HEU-SOL-THERM-033 critical experiment set to design applications containing Pu-nitrate solutions is addressed through an evaluation of the neutron energy spectra in the absorbing medium. The absorbed neutron energy spectrum for the borated concrete region of benchmark experiment configuration 8a is compared to the absorption spectrum for the same region of identical configurations with Pu-nitrate substituted for the U-nitrate in the fissile medium regions. This approach is selected to demonstrate that the neutron absorption spectrum within the absorbing material is insensitive to the source of the neutrons (i.e., Pu-nitrate versus U-nitrate solution systems).

Experiment configuration 8a is selected for the purposes of this applicability demonstration since it is the most heavily borated concrete experiment in the HEU-SOL-THERM-033 set. Experiment 8a incorporates 2.5 weight percent boron in the concrete plug placed in the central region of the annular tank system.

Calculations with Pu-nitrate substituted for U-nitrate fissile medium are created with all other attributes of the HEU-SOL-THERM-033 experiment 8a remaining unaltered. Two Pu-nitrate composition cases are evaluated. In the first case, the concentration of the Pu-nitrate was specified at a value comparable to the high enrichment uranium concentration used in the HEU-SOL-THERM-033 case (i.e., H/X=70). In the second case, a value which represents optimum moderation for the Pu-nitrate isotopic composition is specified (i.e., H/X=125). In both cases, the plutonium isotopic distribution assumed is 96 weight percent Pu-239, and 4 weight percent Pu-240.

Figure 1 presents the neutron absorption energy spectra results for the three fissile medium cases evaluated. The results indicate that the borated concrete absorption spectra are similar for the three fissile medium cases evaluated and that the absorption spectra are relatively insensitive to the fissile medium composition (i.e., high enrichment uranium versus plutonium). This favorable comparison of absorption spectra supports the use of U-nitrate based benchmark experiment data in the validation of the CSAS26/238GROUPNDF5 criticality analysis method for the limited purpose of extrapolating the AOA(1) USL result to Pu-nitrate solution systems containing borated concrete as a supplemental neutron absorber.

AREA(S) OF APPLICABILITY DETERMINATION

The general arrangement of the HEU-SOL-THERM-033 critical experiments supports a conclusion that the experiments evaluated encompass the entire AOA of any MFFF Pu-nitrate design application that incorporates borated concrete as a neutron absorber material. This conclusion is based on the experiment arrangement that places borated concrete plugs in the central cavity formed by annular steel tanks containing fissile aqueous solutions. In addition to being physically similar to MFFF design applications where annular tanks are utilized with borated concrete incorporated in the central cavity, the experiment arrangements place borated concrete in a position where the absorber acts to limit interaction between opposite sides of an annular tank. Thus, the experimental arrangements incorporate the neutron absorber in a high reactivity worth region of a fissile system relative to other typical design application

arrangements. Other design application arrangements involving borated concrete supplemental neutron absorber materials include reflectors external to cylindrical tank outer radial surfaces, or interaction control shields placed between physically separated fissile solution containing tanks or components.

Although the physical arrangement of the HEU-SOL-THERM-033 critical experiments supports a favorable AOA conclusion, additional analysis is necessary to fully establish the area of applicability encompassed by the borated concrete benchmark experiments included in the experiment set. Borated concrete supplemental neutron absorber materials are typically placed in a close proximity reflector region to reduce neutron reflection back into the source fissile unit, or at more remote locations between fissile units/regions to limit interaction. In any case, the borated concrete absorber will have only limited impact on the neutron spectrum characteristics of the fissile medium in aqueous solution fissile systems where the absorber is situated outside and separate from the fissile solution. Any impact on the neutron spectrum characteristics of the fissile medium is expected to be well within the fission spectrum encompassed by the AOA(1) bias basis benchmark experiment set (i.e., see Figure 6.2 of main report). Therefore, the most relevant trending parameter(s) would measure the effectiveness of the material as an absorber rather than its potential effect on a characteristic of the fissile medium, such as Energy of Average Lethargy Causing Fission (EALF). Both boron-10 (B-10) and hydrogen content are important characteristics of borated concrete absorber materials and are thus selected as additional AOA trending parameters.

Trending analysis on the B-10 and hydrogen content of materials placed in the central cavity of the annular tank experiments is performed to provide additional insights into the AOA encompassed by the HEU-SOL-THERM-033 critical experiment set. The calculated bias results presented in Table 1 and the HEU-SOL-THERM-033 critical experiment material atom density information provided in the International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999) are used to produce a trending analysis. Trending analysis results are presented in Figures 2 and 3 for B-10 and hydrogen content, respectively.

The trending analysis results do not indicate any strong trends exist within the AOA covered by the experiment set (i.e., 0 to 5.4E-4 atoms/barn-cm B-10, and 0 to 6.6E-2 atoms/barn-cm for hydrogen). Although the benchmark experiment AOA for B-10 content is limited to a maximum of 5.4E-4 atoms/barn-cm B-10, the trending analysis presented in Figure 2 supports the conclusion that extrapolation of benchmark evaluation results beyond the evaluated AOA is acceptable. The data presented for hydrogen content spans a wide range of conditions from dry air to full density pure water. Thus, the hydrogen content AOA encompasses the borated concrete absorber material used in design applications.

SUMMARY

Results calculated by the CSAS26/238GROUPNDF5 criticality analysis methodology for U-nitrate aqueous solution benchmark experiments containing borated concrete, borated plaster, borated water, boron-free concrete, boron-free water, and void within the central cavity of an annular tank fissile configuration are presented. Comparisons of results for experiments containing borated materials against results for non-borated materials were performed. The

comparisons did not indicate any significant bias exists between CSAS26/238GROUPNDF5 criticality analysis methodology calculated results for systems that contain borated neutron absorber materials relative to systems that are boron-free.

A comparison is also presented to demonstrate the applicability of the U-nitrate solution benchmark experiment conclusions to systems that contain Pu-nitrate aqueous solutions as a fissile medium (i.e., with respect to potential biases introduced by the presence of external borated neutron absorber materials). The absorbed neutron energy spectrum within the borated concrete medium is obtained from CSAS26 output for benchmark experiment configuration 8a (i.e., 2.5 weight percent boron case). Similar spectrum data are obtained for experiment 8a where the U-nitrate solution was replaced with Pu-nitrate with H/X ratios of 70 and 125. The absorbed neutron energy spectrum data for borated concrete was not significantly affected by substituting Pu-nitrate for the U-nitrate solution used in the actual experiment. This favorable comparison demonstrates that the neutron absorption characteristics of borated concrete incorporated separate and external to the fissile medium is not significantly affected by the fissile medium composition, and that the U-nitrate experiment derived borated concrete method bias conclusions are also applicable to Pu-nitrate aqueous solution systems.

Trending analyses are presented for borated concrete B-10 and hydrogen content for the purposes of establishing the AOA covered by the experiment set. Based on the results of this AOA trending analysis, it is concluded that the USL-1=0.9370 acceptance criterion can be assumed applicable to Pu-nitrate aqueous solution systems incorporating borated concrete external to the fissile medium over a wide range of borated concrete hydrogen or B-10 content.

Table 1. CSAS Results for All Experiments in HEU-SOL-THERM-033

Experiment	Experiment/Case Description	OECD Result [1]		CSAS26; 238		Benchmark Model Bias & Uncertainty [2]			CSAS26; 238
		k_{eff}	1-Sigma	k_{eff}	1-Sigma	k_{eff}	Bias	Uncertainty	Bias [5]
1	2a; None	1.0019	0.0011	0.9996	0 0012	0 9979	-0 0021	0 0112	0.0017
2	2b; None	0 9982	0 0012	0 9984	0.0012	1.0000	0.0000	0.0109	-0 0016
3	2c; None	0.9996	0.0010	0.9981	0 0010	0.9979	-0 0021	0 0067	0.0002
4	3a; Conc	1.0015	0.0011	1.0014	0 0013	0 9942	-0 0058	0.0115	0.0072
5	3b; Conc.	1 0032	0.0010	1 0019	0.0013	0.9979	-0 0021	0 0112	0 0040
6	3c, Conc.	1.0110	0.0012	1.0125	0.0012	0.9979	-0 0021	0 0072	0 0146
7	4a; Conc. & Cd	0.9994	0 0011	1 0004	0 0013	0 9942	-0.0058	0.0115	0 0062
8	4b; Conc. & Cd	1 0078	0 0011	1.0060	0.0013	0.9979	-0 0021	0 0112	0.0081
9	5a; 1.2 w/o B-Conc.	1 0087	0.0011	1 0077	0 0012	0 9942	-0 0058	0.0112	0.0135
10	5b; 1.2 w/o B-Conc.	1.0077	0 0012	1 0085	0 0014	1.0000	0.0000	0 0109	0 0085
11	6a; 1.2 w/o B-Conc.	1.0031	0 0011	1.0022	0.0013	0 9942	-0 0058	0 0112	0.0080
12	6b; 1 2 w/o B-Conc.	1.0079	0.0011	1 0108	0 0012	1.0000	0 0000	0.0109	0 0108
13	7a; 1.1 w/o B-Plast.	0.9987	0.0011	0 9993	0.0012	0.9942	-0 0058	0 0112	0 0051
14	7b; 1.1 w/o B-Plast.	1.0053	0.0010	1.0058	0 0013	1.0000	0.0000	0.0109	0 0058
15	8a; 2.5 w/o B-Conc.	1.0026	0 0010	1.0034	0.0011	0.9942	-0.0058	0.0112	0 0092
16	8b, 2.5 w/o B-Conc.	1 0055	0 0011	1.0072	0.0013	1.0000	0 0000	0 0109	0.0072
17	9a; 1.1 w/o B-Plast.	0.9984	0 0011	0 9954	0 0012	0 9942	-0.0058	0 0112	0 0012
18	9b; 1.1 w/o B-Plast.	0 9961	0.0012	0.9971	0.0012	1.0000	0 0000	0 0109	-0.0029
19	9c; 1.1 w/o B-Plast	0.9967	0.0012	0.9931	0 0012	0 9979	-0 0021	0.0105	-0.0048
20	10a; Conc.	1.0025	0.0011	1 0021	0 0011	0.9942	-0.0058	0 0115	0 0079
21	10c; Conc.	1.0027	0.0011	1.0016	0.0011	0.9979	-0.0021	0 0072	0.0036
22	10d; Conc.	0.9929	0.0011	0.9947	0.0013	0 9979	-0 0021	0.0106	-0 0032
23	11a; Water	1.0012	0 0012	1 0000	0.0012	0.9942	-0.0058	0 0112	0 0058
24	11b; Water	1 0013	0 0012	0 9982	0.0012	0.9979	-0 0021	0.0109	0.0003
25	12a; B-Water	0.9997	0.0011	0.9986	0 0011	0 9942	-0 0058	0.0112	0 0044
26	12b; B-Water	0.9996	0.0011	1 0019	0.0011	1.0000	0 0000	0 0109	0 0019
	Mean	1 0020		1.0018		0 9970	-0 0030	0 0106	
	Standard Deviation +/-	0 0043		0 0049					
	Method Bias [3]	0.0050		0 0047					
	Uncertainty in Bias [4] +/-	0 0115		0.0117					

NOTES.

[1] Table 49, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[2] Table 47, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[3] Method Bias = Mean - Mean Benchmark Model

[4] Uncertainty in Bias = (Standard Deviation^2 + Mean Benchmark Model Uncertainty^2)$^{0.5}$

[5] CSAS26 Bias = CSAS26; 238 k_{eff} - Benchmark Model k_{eff}.

Table 2. CSAS Results for Experiments in HEU-SOL-THERM-033; No Borated Concrete or Plaster

Experiment	Experiment/Case Description	OECD Result [1]		CSAS26; 238		Benchmark Model Bias & Uncertainty [2]			CSAS26; 238 Bias [5]
		k_{eff}	1-Sigma	k_{eff}	1-Sigma	k_{eff}	Bias	Uncertainty	
1	2a; None	1.0019	0.0011	0.9996	0.0012	0.9979	-0.0021	0.0112	0.0017
2	2b; None	0.9982	0.0012	0.9984	0.0012	1.0000	0.0000	0.0109	-0.0016
3	2c; None	0.9996	0.0010	0.9981	0.0010	0.9979	-0.0021	0.0067	0 0002
4	3a; Conc.	1.0015	0.0011	1.0014	0.0013	0.9942	-0.0058	0.0115	0.0072
5	3b; Conc.	1.0032	0.0010	1.0019	0.0013	0.9979	-0.0021	0.0112	0.0040
6	3c; Conc.	1.0110	0.0012	1.0125	0.0012	0.9979	-0.0021	0.0072	0 0146
7	4a; Conc. & Cd	0.9994	0.0011	1.0004	0.0013	0.9942	-0.0058	0.0115	0.0062
8	4b; Conc. & Cd	1.0078	0.0011	1.0060	0.0013	0.9979	-0.0021	0 0112	0.0081
9	10a; Conc.	1.0025	0.0011	1.0021	0.0011	0.9942	-0.0058	0.0115	0.0079
10	10c; Conc.	1.0027	0.0011	1.0016	0.0011	0 9979	-0.0021	0.0072	0.0036
11	10d; Conc.	0.9929	0.0011	0.9947	0.0013	0.9979	-0.0021	0.0106	-0.0032
12	11a; Water	1.0012	0.0012	1.0000	0.0012	0.9942	-0.0058	0.0112	0.0058
13	11b; Water	1.0013	0.0012	0.9982	0.0012	0.9979	-0.0021	0.0109	0.0003
14	12a; B-Water	0.9997	0.0011	0.9986	0.0011	0.9942	-0.0058	0.0112	0.0044
15	12b; B-Water	0.9996	0.0011	1.0019	0.0011	1.0000	0.0000	0.0109	0.0019
	Mean	1.0015		1.0010		0.9969	-0.0031	0.0103	
	Standard Deviation +/-	0.0041		0.0041					
	Method Bias [3]	0.0046		0.0041					
	Uncertainty in Bias [4] +/-	0 0111		0.0111					

NOTES:

[1] Table 49, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[2] Table 47, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[3] Method Bias = Mean - Mean Benchmark Model

[4] Uncertainty in Bias = $(\text{Standard Deviation}^2 + \text{Mean Benchmark Model Uncertainty}^2)^{0.5}$

[5] CSAS26 Bias = CSAS26; 238 k_{eff} - Benchmark Model k_{eff}.

Table 3. CSAS Results for Experiments in HEU-SOL-THERM-033; No Boron-free Concrete

Experiment	Experiment/Case Description	OECD Result [1]		CSAS26; 238		Benchmark Model Bias & Uncertainty [2]			CSAS26; 238 Bias [5]
		k_{eff}	1-Sigma	k_{eff}	1-Sigma	k_{eff}	Bias	Uncertainty	
1	2a; None	1.0019	0.0011	0.9996	0.0012	0.9979	-0.0021	0.0112	0.0017
2	2b; None	0.9982	0.0012	0.9984	0.0012	1.0000	0.0000	0.0109	-0.0016
3	2c; None	0.9996	0.0010	0.9981	0.0010	0.9979	-0.0021	0.0067	0.0002
4	5a; 1.2 w/o B-Conc.	1 0087	0.0011	1.0077	0.0012	0.9942	-0.0058	0.0112	0.0135
5	5b; 1.2 w/o B-Conc.	1.0077	0.0012	1.0085	0.0014	1.0000	0.0000	0.0109	0.0085
6	6a; 1.2 w/o B-Conc.	1.0031	0.0011	1.0022	0.0013	0.9942	-0.0058	0.0112	0.0080
7	6b; 1.2 w/o B-Conc.	1.0079	0.0011	1.0108	0.0012	1.0000	0.0000	0.0109	0.0108
8	7a; 1.1 w/o B-Plast.	0.9987	0.0011	0.9993	0.0012	0.9942	-0.0058	0.0112	0.0051
9	7b; 1.1 w/o B-Plast.	1.0053	0.0010	1.0058	0.0013	1.0000	0.0000	0.0109	0 0058
10	8a; 2.5 w/o B-Conc.	1.0026	0.0010	1.0034	0.0011	0.9942	-0.0058	0.0112	0.0092
11	8b; 2.5 w/o B-Conc.	1.0055	0.0011	1.0072	0.0013	1.0000	0.0000	0.0109	0.0072
12	9a; 1.1 w/o B-Plast.	0.9984	0.0011	0.9954	0.0012	0.9942	-0.0058	0.0112	0.0012
13	9b; 1.1 w/o B-Plast.	0.9961	0.0012	0.9971	0.0012	1.0000	0.0000	0.0109	-0.0029
14	9c; 1.1 w/o B-Plast.	0.9967	0.0012	0.9931	0.0012	0.9979	-0.0021	0.0105	-0.0048
15	11a; Water	1.0012	0.0012	1.0000	0.0012	0.9942	-0 0058	0.0112	0.0058
16	11b; Water	1.0013	0 0012	0.9982	0.0012	0.9979	-0 0021	0.0109	0.0003
17	12a; B-Water	0.9997	0 0011	0.9986	0.0011	0.9942	-0.0058	0.0112	0.0044
18	12b; B-Water	0.9996	0.0011	1.0019	0.0011	1.0000	0.0000	0.0109	0.0019
	Mean	1.0018		1.0014		0.9973	-0.0027	0.0108	
	Standard Deviation +/-	0.0039		0.0049					
	Method Bias [3]	0.0045		0.0041					
	Uncertainty in Bias [4] +/-	0.0115		0.0118					

NOTES:

[1] Table 49, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[2] Table 47, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[3] Method Bias = Mean - Mean Benchmark Model

[4] Uncertainty in Bias = $(\text{Standard Deviation}^2 + \text{Mean Benchmark Model Uncertainty}^2)^{0.5}$

[5] CSAS26 Bias = CSAS26; 238 k_{eff} - Benchmark Model k_{eff}.

Table 4. CSAS Results for Experiments in HEU-SOL-THERM-033; All Concrete and Plaster Only

Experiment	Experiment/Case Description	OECD Result [1]		CSAS26; 238		Benchmark Model Bias & Uncertainty [2]			CSAS26; 238
		k_{eff}	1-Sigma	k_{eff}	1-Sigma	k_{eff}	Bias	Uncertainty	Bias [5]
1	3a; Conc.	1.0015	0.0011	1.0014	0.0013	0.9942	-0.0058	0.0115	0.0072
2	3b; Conc.	1.0032	0.0010	1.0019	0.0013	0.9979	-0.0021	0.0112	0.0040
3	3c; Conc.	1.0110	0.0012	1.0125	0.0012	0.9979	-0.0021	0.0072	0.0146
4	4a; Conc. & Cd	0.9994	0.0011	1.0004	0.0013	0.9942	-0.0058	0.0115	0.0062
5	4b; Conc. & Cd	1.0078	0.0011	1.0060	0.0013	0.9979	-0.0021	0.0112	0.0081
6	5a; 1.2 w/o B-Conc.	1.0087	0.0011	1.0077	0.0012	0.9942	-0.0058	0.0112	0.0135
7	5b; 1.2 w/o B-Conc.	1.0077	0.0012	1.0085	0.0014	1.0000	0.0000	0.0109	0.0085
8	6a; 1.2 w/o B-Conc.	1 0031	0.0011	1.0022	0.0013	0.9942	-0.0058	0.0112	0.0080
9	6b; 1.2 w/o B-Conc.	1.0079	0.0011	1.0108	0.0012	1.0000	0.0000	0.0109	0.0108
10	7a; 1.1 w/o B-Plast.	0.9987	0.0011	0.9993	0.0012	0.9942	-0.0058	0.0112	0 0051
11	7b; 1.1 w/o B-Plast.	1.0053	0.0010	1.0058	0.0013	1.0000	0.0000	0.0109	0 0058
12	8a; 2.5 w/o B-Conc.	1.0026	0.0010	1.0034	0.0011	0.9942	-0.0058	0 0112	0.0092
13	8b; 2.5 w/o B-Conc.	1.0055	0.0011	1.0072	0.0013	1.0000	0.0000	0.0109	0.0072
14	9a; 1.1 w/o B-Plast.	0.9984	0.0011	0.9954	0.0012	0.9942	-0.0058	0.0112	0.0012
15	9b; 1.1 w/o B-Plast.	0.9961	0.0012	0.9971	0.0012	1.0000	0.0000	0.0109	-0.0029
16	9c; 1.1 w/o B-Plast.	0.9967	0.0012	0.9931	0.0012	0.9979	-0.0021	0.0105	-0.0048
17	10a; Conc.	1.0025	0.0011	1.0021	0.0011	0.9942	-0.0058	0.0115	0.0079
18	10c; Conc.	1.0027	0.0011	1.0016	0.0011	0.9979	-0.0021	0.0072	0.0036
19	10d; Conc.	0.9929	0.0011	0.9947	0.0013	0.9979	-0.0021	0.0106	-0.0032
	Mean	1.0027		1.0027		0.9969	-0.0031	0.0107	
	Standard Deviation +/-	0.0048		0.0054					
	Method Bias [3]	0.0058		0.0058					
	Uncertainty in Bias [4] +/-	0.0117		0.0120					

NOTES:

[1] Table 49, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[2] Table 47, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[3] Method Bias = Mean - Mean Benchmark Model

[4] Uncertainty in Bias = $(\text{Standard Deviation}^2 + \text{Mean Benchmark Model Uncertainty}^2)^{0.5}$

[5] CSAS26 Bias = CSAS26; 238 k_{eff} - Benchmark Model k_{eff}.

Table 5. CSAS Results for Experiments in HEU-SOL-THERM-033; Borated Concrete and Plaster Only

Experiment	Experiment/Case Description	OECD Result [1]		CSAS26; 238		Benchmark Model Bias & Uncertainty [2]			CSAS26; 238 Bias [5]
		k_{eff}	1-Sigma	k_{eff}	1-Sigma	k_{eff}	Bias	Uncertainty	
1	5a; 1.2 w/o B-Conc.	1.0087	0.0011	1.0077	0.0012	0.9942	-0.0058	0.0112	0.0135
2	5b; 1.2 w/o B-Conc.	1.0077	0.0012	1.0085	0.0014	1.0000	0.0000	0.0109	0.0085
3	6a; 1.2 w/o B-Conc.	1.0031	0.0011	1.0022	0.0013	0.9942	-0.0058	0.0112	0.0080
4	6b; 1.2 w/o B-Conc.	1.0079	0.0011	1.0108	0.0012	1.0000	0.0000	0.0109	0.0108
5	7a; 1.1 w/o B-Plast.	0.9987	0.0011	0.9993	0.0012	0.9942	-0.0058	0.0112	0.0051
6	7b; 1.1 w/o B-Plast.	1.0053	0.0010	1.0058	0.0013	1.0000	0.0000	0.0109	0.0058
7	8a; 2.5 w/o B-Conc.	1.0026	0.0010	1.0034	0.0011	0.9942	-0.0058	0.0112	0.0092
8	8b; 2.5 w/o B-Conc.	1.0055	0.0011	1.0072	0.0013	1.0000	0.0000	0.0109	0.0072
9	9a; 1.1 w/o B-Plast.	0.9984	0.0011	0.9954	0.0012	0.9942	-0.0058	0.0112	0.0012
10	9b; 1.1 w/o B-Plast.	0.9961	0.0012	0.9971	0.0012	1.0000	0.0000	0.0109	-0.0029
11	9c; 1.1 w/o B-Plast.	0.9967	0.0012	0.9931	0.0012	0.9979	-0.0021	0.0105	-0.0048
	Mean	1.0028		1.0028		0.9972	-0.0028	0.0110	
	Standard Deviation +/-	0.0047		0.0059					
	Method Bias [3]	0.0056		0.0056					
	Uncertainty in Bias [4] +/-	0.0119		0.0125					

NOTES:

[1] Table 49, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[2] Table 47, International Handbook of Evaluated Criticality Safety Benchmark Experiments (Nuclear Energy Agency 1999).

[3] Method Bias = Mean - Mean Benchmark Model

[4] Uncertainty in Bias = (Standard Deviation^2 + Mean Benchmark Model Uncertainty^2)$^{0.5}$

[5] CSAS26 Bias = CSAS26; 238 k_{eff} - Benchmark Model k_{eff}.

Table 6. Summary of Grouped Statistics Results

Experiment Group	CSAS26/238GROUPNDF5			
	Mean	Standard Deviation (+/-)	Method Bias	Uncertainty in Bias (+/-)
All Experiments (Table 1)	1.0018	0.0049	0.0047	0.0117
No Borated Concrete or Plaster (Table 2)	1.0010	0.0041	0.0041 [1]	0.0111
No Boron-free Concrete (Table 3)	1.0014	0.0049	0.0041	0.0118
All Concrete and Plaster Only (Table 4)	1.0027	0.0054	0.0058	0.0120
Borated Concrete and Plaster Only (Table 5)	1.0028	0.0059	0.0056 [1]	0.0125

NOTE:

[1] Evaluated variation in CSAS26/238GROUPNDF method bias for systems "with" vs. "without" borated supplemental neutron absorber materials = 0.0015 = 0.0056 - 0.0041.

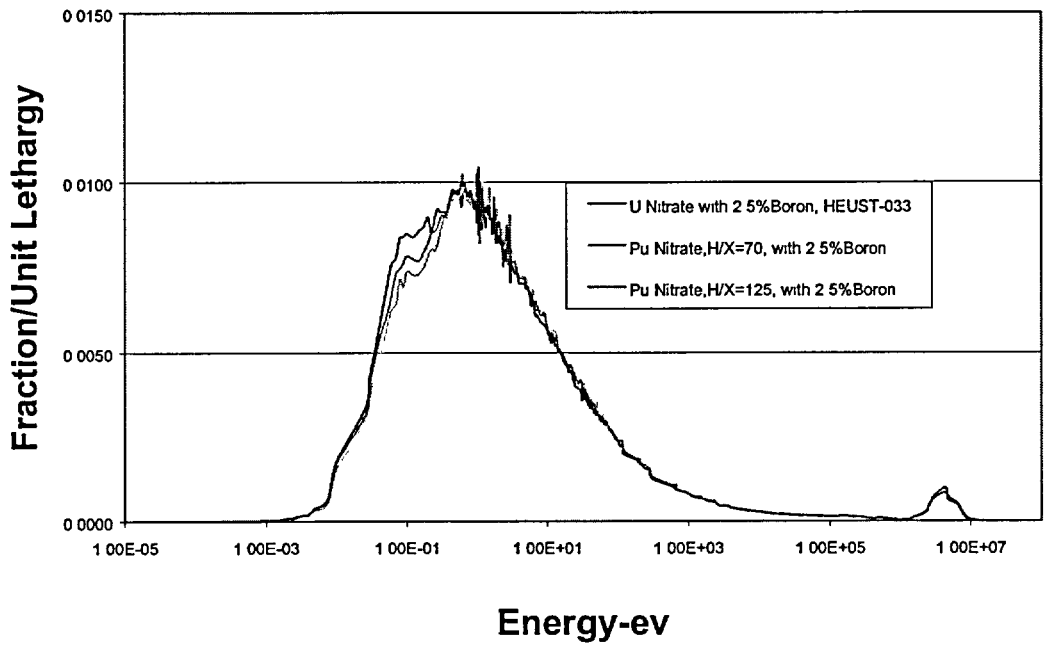

Figure 1. Borated Concrete Absorption Spectra

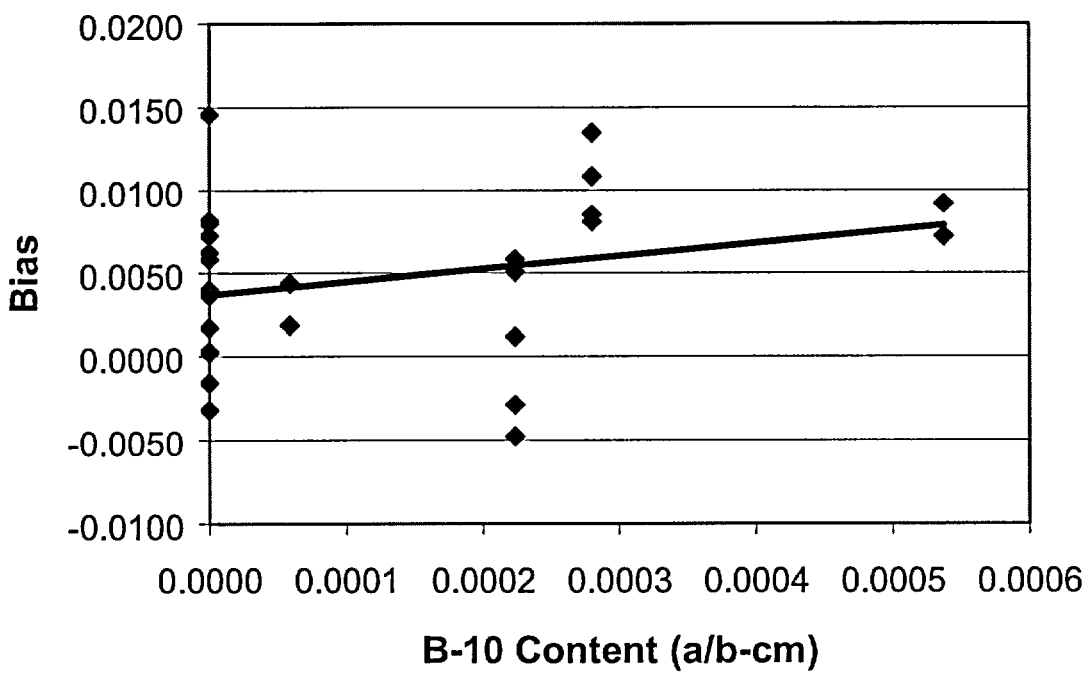

Figure 2. Bias versus B-10 Content

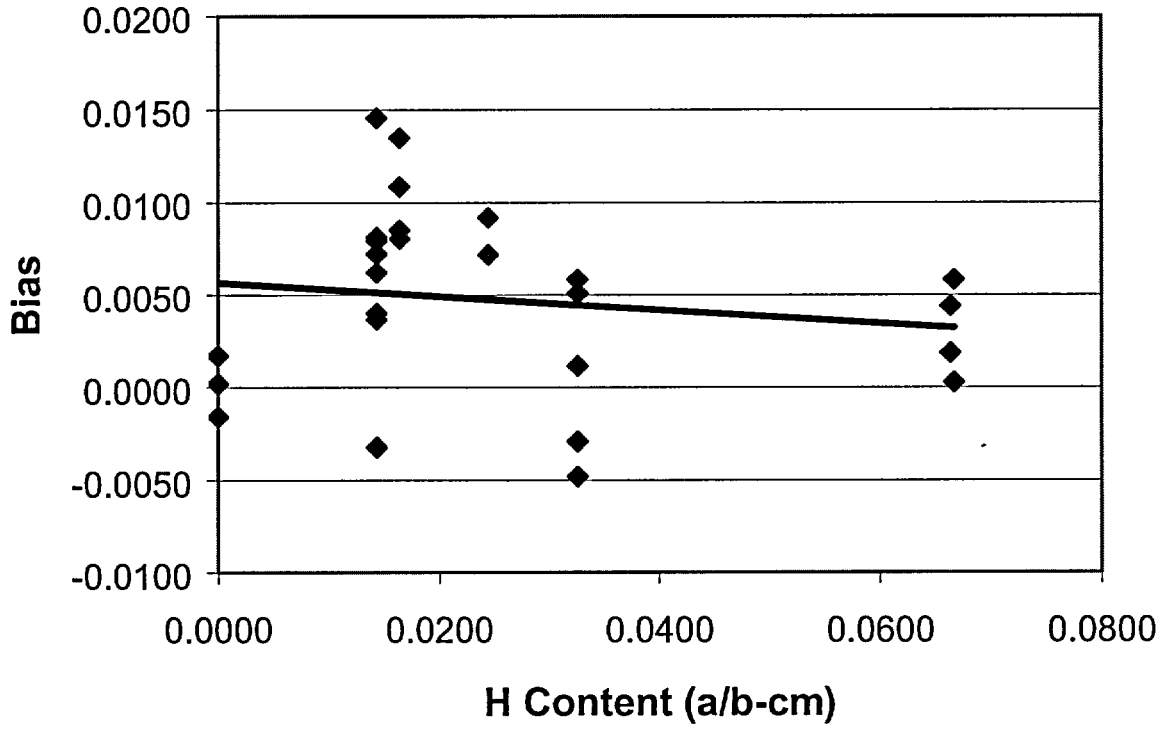

Figure 3. Bias versus H Content

ATTACHMENT 6

CONCRETE AND CD/WATER REFLECTORS

INTRODUCTION

The 191 critical experiments modeled for AOA(1) (see Section 6.1) include bare spheres, water reflected spheres, concrete reflected spheres, cadmium/concrete reflected spheres, and cadmium/water reflected spheres. This attachment divides the set into three subgroups (i.e., concrete reflector, Cd/water reflector, and water reflector experiments) to evaluate whether the full group of 191 experiments adequately encompasses the subgroups.

USL FOR EXPERIMENTS WITH CONCRETE REFLECTORS

Twenty-nine experiments were selected using the PU-SOL-THERM-008 benchmark evaluations to evaluate the effect of concrete reflectors on the reactivity of the system. These experiments have similar characteristics:

- Pu-nitrate solution (30 g/l < C(Pu) < 100 g/l , 4.1% < % ^{240}Pu < 4.6%)
- Spherical geometry
- Concrete reflector or cadmium/concrete reflector.

The evaluations include 24 experiments with a concrete reflector and five experiments with cadmium and concrete reflectors.

EXPERIMENTS WITH CADMIUM/WATER REFLECTOR

Fourteen experiments were selected from the benchmark experiment PU-SOL-THERM-020 to evaluate the effect of water and cadmium/water reflectors on the reactivity of the system. These experiments were further divided to those experiments with and without Cd. The experiments have the following characteristics:

- Pu-nitrate solution (30 g/l < C(Pu) < 70 g/l , 4.67 % ^{240}Pu)
- Spherical geometry.

Ten experiments are reflected by water and four are reflected by cadmium/water.

SUMMARY

Table 1 provides a comparison of the mean k_{eff} of each subset with the mean k_{eff} from the full set. The table indicates that the bias is positive for all cases and that there is no significant difference in the bias results. Furthermore, the variation is small compared to the level of uncertainty in the computational bias accounted for in the determination of USL-1 in Section 6.1 of the report. Therefore, since the subsets are included in the calculation of the USL and computational bias established for AOA(1), the USL and range established for the AOA(1) is applicable to the subsets of concrete reflectors, Cd/water reflectors, and water reflectors.

Table 1. Mean calculated k_{eff} for full set and subsets of AOA(1) benchmarks

	Sun Results (SCALE 4.4)					PC Results (SCALE 4.4a)				
Metric	**All**	**Concrete**	**Cd/Conc**	**Water**	**Cd/H2O**	**All**	**Concrete**	**Cd/Conc**	**Water**	**Cd/H2O**
Num Exp	191	29	5	10	4	191	29	5	10	4
Avg k	1.0096	1.0177	1.0017	1.0070	1.0032	1.0095	1.0177	1.0014	1.0073	1.0019
σ of Avg	0.0046	0.0042	0.0053	0.0060	0.0061	0.0045	0.0040	0.0052	0.0060	0.0060
Min k	0.9968	0.9976	0.9976	1.0021	1.0004	0.9948	0.9948	0.9948	1.0022	0.9989
Max k	1.0320	1.0320	1.0060	1.0113	1.0096	1.0317	1.0317	1.0071	1.0104	1.0069

ATTACHMENT 7

INPUT AND OUTPUT FILES

The files listed in Figure 1 are provided on the attached compact disc media.

Figure 1 – Listing of Files on Attached Media

```
Volume in drive D is Part1Att7
 Volume Serial Number is 79BF-72FF

Directory of D:\

CASES          <DIR>        10-04-01  2:06p CASES
        0 file(s)               0 bytes

Directory of D:\CASES

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p  .
PC             <DIR>        10-04-01  2:06p PC
SUN            <DIR>        10-04-01  2:06p Sun
        0 file(s)               0 bytes

Directory of D:\CASES\PC

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
AOA1           <DIR>        10-04-01  2:06p AoA1
AOA2           <DIR>        10-04-01  2:06p AoA2
        0 file(s)               0 bytes

Directory of D:\CASES\PC\AoA1

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PST_001        <DIR>        10-04-01  2:06p PST_001
PST_002        <DIR>        10-04-01  2:06p PST_002
PST_003        <DIR>        10-04-01  2:06p PST_003
PST_004        <DIR>        10-04-01  2:06p PST_004
PST_005        <DIR>        10-04-01  2:06p PST_005
PST_006        <DIR>        10-04-01  2:06p PST_006
PST_008        <DIR>        10-04-01  2:06p PST_008
PST_011        <DIR>        10-04-01  2:06p PST_011
PST_014        <DIR>        10-04-01  2:06p PST_014
PST_015        <DIR>        10-04-01  2:06p PST_015
PST_016        <DIR>        10-04-01  2:06p PST_016
PST_017        <DIR>        10-04-01  2:06p PST_017
PST_020        <DIR>        10-04-01  2:06p PST_020
PST_025        <DIR>        10-04-01  2:06p PST_025
PST_026        <DIR>        10-04-01  2:06p PST_026
USL            <DIR>        10-04-01  2:06p usl
        0 file(s)               0 bytes

Directory of D:\CASES\PC\AoA1\PST_001

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6 OUT       799,698  05-31-01  3:27p PU_SOL_TH_001_5_T8A_k6.out
PU_SOL~8 INP         4,312  05-29-01  3:51p PU_SOL_TH_001_6_T8A_k6.inp
PU_SO~10 OUT       800,013  05-31-01  3:46p PU_SOL_TH_001_6_T8A_k6.out
PU_SO~12 INP         4,312  05-30-01 11:07a PU_SOL_TH_001_5_T8A_k6.inp
PU_SO~14 INP         4,312  05-30-01 11:07a PU_SOL_TH_001_1_T8A_k6.inp
PU_SO~16 OUT       797,910  05-31-01  2:05p PU_SOL_TH_001_1_T8A_k6.out
PU_SO~18 INP         4,311  05-29-01  3:51p PU_SOL_TH_001_2_T8A_k6.inp
PU_SO~20 OUT       793,956  05-31-01  2:26p PU_SOL_TH_001_2_T8A_k6.out
PU_SO~22 INP         4,311  05-29-01  3:51p PU_SOL_TH_001_3_T8A_k6.inp
PU_SO~24 OUT       799,854  05-31-01  2:46p PU_SOL_TH_001_3_T8A_k6.out
PU_SO~26 INP         4,312  05-29-01  3:51p PU_SOL_TH_001_4_T8A_k6.inp
PU_SO~28 OUT       801,932  05-31-01  3:07p PU_SOL_TH_001_4_T8A_k6.out
       12 file(s)      4,819,233 bytes

Directory of D:\CASES\PC\AoA1\PST_002

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
GETKEN~6 TXT           731  09-21-01  3:05p getkeno txt~
PU_SOL~8 INP         4,079  06-01-01  6:14p PU_SOL_TH_002_3_k6_R2.inp
PU_SO~10 OUT       768,544  06-01-01  8:56p PU_SOL_TH_002_3_k6_R2.out
PU_SO~12 INP         4,065  05-29-01  3:50p PU_SOL_TH_002_3_k6.inp
PU_SO~14 INP         4,065  05-29-01  3:50p PU_SOL_TH_002_4_k6.inp
PU_SO~16 INP         4,065  05-29-01  3:50p PU_SOL_TH_002_5_k6.inp
PU_SO~18 INP         4,065  05-29-01  3:50p PU_SOL_TH_002_6_k6.inp
PU_SO~20 INP         4,065  05-29-01  3:50p PU_SOL_TH_002_7_k6.inp
PU_SO~22 OUT       770,538  05-31-01  4:51p PU_SOL_TH_002_3_k6.out
PU_SO~24 OUT       771,987  05-31-01  5:13p PU_SOL_TH_002_4_k6.out
PU_SO~26 OUT       773,611  05-31-01  5:34p PU_SOL_TH_002_5_k6.out
PU_SO~28 OUT       771,385  05-31-01  5:55p PU_SOL_TH_002_6_k6.out
PU_SO~30 OUT       772,891  05-31-01  6:16p PU_SOL_TH_002_7_k6.out
PU_SO~32 INP         4,065  05-29-01  3:50p PU_SOL_TH_002_1_k6.inp
PU_SO~34 OUT       772,314  05-31-01  4:08p PU_SOL_TH_002_1_k6.out
PU_SO~36 INP         4,080  06-01-01  6:12p PU_SOL_TH_002_1_k6_R2.inp
PU_SO~38 OUT       771,626  06-01-01  7:11p PU_SOL_TH_002_1_k6_R2.out
```

```
PU_SO-40 INP          4,065  05-29-01  3:50p PU_SOL_TH_002_2_k6.inp
PU_SO-42 OUT        769,185  05-31-01  4:30p PU_SOL_TH_002_2_k6.out
PU_SO-44 INP          4,079  06-01-01  6:14p PU_SOL_TH_002_2_k6_R2.inp
PU_SO-46 OUT        768,650  06-01-01  8:04p PU_SOL_TH_002_2_k6_R2.out
        21 file(s)      7,752,155 bytes

Directory of D:\CASES\PC\AoA1\PST_003

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_5_k6.inp
PU_SOL-8 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_6_k6.inp
PU_SO-10 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_7_k6.inp
PU_SO-12 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_8_k6.inp
PU_SO-14 OUT        793,539  05-31-01  8:04p PU_SOL_TH_003_5_k6.out
PU_SO-16 OUT        792,015  05-31-01  8:25p PU_SOL_TH_003_6_k6.out
PU_SO-18 OUT        792,918  05-31-01  8:48p PU_SOL_TH_003_7_k6.out
PU_SO-20 OUT        788,215  05-31-01  9:10p PU_SOL_TH_003_8_k6.out
PU_SO-22 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_1_k6.inp
PU_SO-24 OUT        787,931  05-31-01  6:38p PU_SOL_TH_003_1_k6.out
PU_SO-26 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_2_k6.inp
PU_SO-28 OUT        789,006  05-31-01  7:00p PU_SOL_TH_003_2_k6.out
PU_SO-30 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_3_k6.inp
PU_SO-32 OUT        792,714  05-31-01  7:21p PU_SOL_TH_003_3_k6.out
PU_SO-34 INP          4,475  05-29-01  3:49p PU_SOL_TH_003_4_k6 inp
PU_SO-36 OUT        792,646  05-31-01  7:43p PU_SOL_TH_003_4_k6.out
        16 file(s)      6,364,784 bytes

Directory of D:\CASES\PC\AoA1\PST_004

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p  .
PU_SOL-6 INP          4,148  05-29-01  3:48p PU_SOL_TH_004_13_k6.inp
PU_SOL-8 INP          4,148  05-29-01  3:48p PU_SOL_TH_004_12_k6.inp
PU_SO-10 INP          4,066  05-29-01  3:48p PU_SOL_TH_004_10_k6.inp
PU_SO-12 INP          4,066  05-29-01  3:48p PU_SOL_TH_004_11_k6.inp
PU_SO-14 INP          4,066  05-29-01  3:47p PU_SOL_TH_004_08_k6.inp
PU_SO-16 INP          4,066  05-29-01  3:47p PU_SOL_TH_004_07_k6.inp
PU_SO-18 INP          4,066  05-29-01  3:47p PU_SOL_TH_004_06_k6.inp
PU_SO-20 INP          4,066  05-29-01  3:48p PU_SOL_TH_004_09_k6.inp
PU_SO-22 INP          4,066  05-29-01  3:47p PU_SOL_TH_004_05_k6.inp
PU_SO-24 OUT        766,296  06-01-01  1:53a PU_SOL_TH_004_13_k6.out
PU_SO-26 OUT        771,950  06-01-01  1:31a PU_SOL_TH_004_12_k6.out
PU_SO-28 OUT        775,140  06-01-01 12:49a PU_SOL_TH_004_10_k6.out
PU_SO-30 OUT        771,351  06-01-01  1:09a PU_SOL_TH_004_11_k6.out
PU_SO-32 OUT        772,067  05-31-01 11:01p PU_SOL_TH_004_05_k6.out
PU_SO-34 OUT        774,476  06-01-01 12:06a PU_SOL_TH_004_08_k6.out
PU_SO-36 OUT        765,432  05-31-01 11:45p PU_SOL_TH_004_07_k6 out
PU_SO-38 OUT        778,825  05-31-01 11:23p PU_SOL_TH_004_06_k6 out
PU_SO-40 OUT        770,913  06-01-01 12:28a PU_SOL_TH_004_09_k6.out
PU_SO-42 INP          4,066  05-29-01  3:47p PU_SOL_TH_004_01_k6.inp
PU_SO-44 OUT        772,413  05-31-01  9:33p PU_SOL_TH_004_01_k6.out
PU_SO-46 INP          4,066  05-29-01  3:48p PU_SOL_TH_004_02_k6.inp
PU_SO-48 OUT        771,390  05-31-01  9:55p PU_SOL_TH_004_02_k6.out
PU_SO-50 INP          4,066  05-29-01  3:48p PU_SOL_TH_004_03_k6 inp
PU_SO-52 OUT        772,206  05-31-01 10:17p PU_SOL_TH_004_03_k6.out
PU_SO-54 INP          4,066  05-29-01  3:48p PU_SOL_TH_004_04_k6.inp
PU_SO-56 OUT        768,429  05-31-01 10:39p PU_SOL_TH_004_04_k6.out
        26 file(s)     10,083,910 bytes

Directory of D:\CASES\PC\AoA1\PST_005

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_8_k6 inp
PU_SOL-8 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_9_k6.inp
PU_SO-10 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_5_k6.inp
PU_SO-12 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_6_k6 inp
PU_SO-14 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_7_k6.inp
PU_SO-16 OUT        772,706  06-01-01  4:42a PU_SOL_TH_005_8_k6 out
PU_SO-18 OUT        776,586  06-01-01  5:04a PU_SOL_TH_005_9_k6 out
PU_SO-20 OUT        768,648  06-01-01  3:40a PU_SOL_TH_005_5_k6 out
PU_SO-22 OUT        771,709  06-01-01  4:00a PU_SOL_TH_005_6_k6.out
PU_SO-24 OUT        773,424  06-01-01  4:21a PU_SOL_TH_005_7_k6 out
PU_SO-26 INP          4,067  05-29-01  3:45p PU_SOL_TH_005_1_k6.inp
PU_SO-28 OUT        775,768  06-01-01  2:15a PU_SOL_TH_005_1_k6 out
PU_SO-30 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_2_k6.inp
PU_SO-32 OUT        772,675  06-01-01  2:36a PU_SOL_TH_005_2_k6 out
PU_SO-34 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_3_k6.inp
PU_SO-36 OUT        772,332  06-01-01  2:58a PU_SOL_TH_005_3_k6 out
PU_SO-38 INP          4,067  05-29-01  3:46p PU_SOL_TH_005_4_k6.inp
PU_SO-40 OUT        770,292  06-01-01  3:19a PU_SOL_TH_005_4_k6 out
        18 file(s)      6,990,743 bytes

Directory of D:\CASES\PC\AoA1\PST_006

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 INP          4,042  05-29-01  3:44p PU_SOL_TH_006_CASE_1_k6 inp
PU_SOL-8 OUT        768,057  06-01-01  5:26a PU_SOL_TH_006_CASE_1_k6 out
PU_SO-10 INP          4,042  05-29-01  3:44p PU_SOL_TH_006_CASE_2_k6.inp
PU_SO-12 OUT        771,522  06-01-01  5:47a PU_SOL_TH_006_CASE_2_k6 out
```

```
PU_SO~14 INP          4,042  05-29-01  3:45p PU_SOL_TH_006_CASE_3_k6.inp
PU_SO~16 OUT        773,418  06-01-01  6:09a PU_SOL_TH_006_CASE_3_k6.out
        6 file(s)       2,325,123 bytes

Directory of D:\CASES\PC\AoA1\PST_008

.              <DIR>         10-04-01  2:06p .
..             <DIR>         10-04-01  2:06p ..
PU_SOL~6 INP          1,636  05-29-01  3:53p PU_SOL_TH_008_case12_k6.inp
PU_SOL~8 INP          1,561  05-29-01  3:54p PU_SOL_TH_008_case11_k6.inp
PU_SO~10 INP          1,561  05-29-01  3:53p PU_SOL_TH_008_case10_k6.inp
PU_SO~12 INP          1,746  05-29-01  3:55p PU_SOL_TH_008_case22_k6.inp
PU_SO~14 INP          1,746  05-29-01  3:55p PU_SOL_TH_008_case21_k6.inp
PU_SO~16 INP          1,661  05-29-01  3:54p PU_SOL_TH_008_case20_k6.inp
PU_SO~18 INP          1,778  05-29-01  3:56p PU_SOL_TH_008_case30_k6.inp
PU_SO~20 INP          1,637  05-29-01  3:56p PU_SOL_TH_008_case08_k6.inp
PU_SO~22 INP          1,561  05-29-01  3:56p PU_SOL_TH_008_case07_k6.inp
PU_SO~24 INP          1,561  05-29-01  3:56p PU_SOL_TH_008_case05_k6.inp
PU_SO~26 INP          1,637  05-29-01  3:53p PU_SOL_TH_008_case09_k6.inp
PU_SO~28 INP          1,779  05-29-01  3:54p PU_SOL_TH_008_case18_k6.inp
PU_SO~30 INP          1,776  05-29-01  3:54p PU_SOL_TH_008_case17_k6.inp
PU_SO~32 INP          1,664  05-29-01  3:54p PU_SOL_TH_008_case15_k6.inp
PU_SO~34 INP          1,749  05-29-01  3:54p PU_SOL_TH_008_case14_k6.inp
PU_SO~36 INP          1,636  05-29-01  3:54p PU_SOL_TH_008_case13_k6.inp
PU_SO~38 INP          1,661  05-29-01  3:54p PU_SOL_TH_008_case16_k6.inp
PU_SO~40 INP          1,661  05-29-01  3:54p PU_SOL_TH_008_case19_k6.inp
PU_SO~42 INP          1,840  05-29-01  3:55p PU_SOL_TH_008_case28_k6.inp
PU_SO~44 INP          1,840  05-29-01  3:55p PU_SOL_TH_008_case27_k6.inp
PU_SO~46 INP          1,866  05-29-01  3:55p PU_SOL_TH_008_case25_k6.inp
PU_SO~48 INP          1,661  05-29-01  3:55p PU_SOL_TH_008_case24_k6.inp
PU_SO~50 INP          1,661  05-29-01  3:55p PU_SOL_TH_008_case23_k6.inp
PU_SO~52 INP          1,749  05-29-01  3:55p PU_SOL_TH_008_case26_k6.inp
PU_SO~54 INP          1,779  05-29-01  3:56p PU_SOL_TH_008_case29_k6.inp
PU_SO~56 OUT        828,802  06-01-01  8:08a PU_SOL_TH_008_case08_k6.out
PU_SO~58 OUT        826,583  06-01-01  7:55a PU_SOL_TH_008_case07_k6.out
PU_SO~60 OUT        825,927  06-01-01  7:27a PU_SOL_TH_008_case05_k6.out
PU_SO~62 OUT        824,934  06-01-01  8:16a PU_SOL_TH_008_case09_k6.out
PU_SO~64 OUT        830,567  06-01-01 11:18a PU_SOL_TH_008_case18_k6.out
PU_SO~66 OUT        828,793  06-01-01 10:59a PU_SOL_TH_008_case17_k6.out
PU_SO~68 OUT        826,692  06-01-01 10:20a PU_SOL_TH_008_case15_k6.out
PU_SO~70 OUT        831,684  06-01-01  9:59a PU_SOL_TH_008_case14_k6.out
PU_SO~72 OUT        828,714  06-01-01  9:44a PU_SOL_TH_008_case13_k6.out
PU_SO~74 OUT        824,088  06-01-01 10:40a PU_SOL_TH_008_case16_k6.out
PU_SO~76 OUT        827,278  06-01-01 11:39a PU_SOL_TH_008_case19_k6.out
PU_SO~78 OUT        825,214  06-01-01  8:40a PU_SOL_TH_008_case10_k6.out
PU_SO~80 OUT        826,129  06-01-01  9:23a PU_SOL_TH_008_case12_k6.out
PU_SO~82 OUT        826,094  06-01-01  9:05a PU_SOL_TH_008_case11_k6.out
PU_SO~84 OUT        828,498  06-01-01  2:49p PU_SOL_TH_008_case28_k6.out
PU_SO~86 OUT        829,182  06-01-01  2:33p PU_SOL_TH_008_case27_k6.out
PU_SO~88 OUT        828,490  06-01-01  1:55p PU_SOL_TH_008_case25_k6.out
PU_SO~90 OUT        827,282  06-01-01  1:32p PU_SOL_TH_008_case24_k6.out
PU_SO~92 OUT        825,308  06-01-01  1:03p PU_SOL_TH_008_case23_k6.out
PU_SO~94 OUT        826,619  06-01-01  2:18p PU_SOL_TH_008_case26_k6.out
PU_SO~96 OUT        826,619  06-01-01  3:12p PU_SOL_TH_008_case29_k6.out
PU_SO~98 OUT        824,112  06-01-01 12:11p PU_SOL_TH_008_case20_k6.out
PU_S~100 OUT        825,474  06-01-01 12:36p PU_SOL_TH_008_case22_k6.out
PU_S~102 OUT        828,056  06-01-01 12:27p PU_SOL_TH_008_case21_k6.out
PU_S~104 OUT        823,251  06-01-01  3:35p PU_SOL_TH_008_case30_k6.out
PU_S~106 INP          1,561  05-29-01  3:56p PU_SOL_TH_008_case01_k6.inp
PU_S~108 OUT        826,186  06-01-01  6:26a PU_SOL_TH_008_case01_k6.out
PU_S~110 INP          1,561  05-29-01  3:55p PU_SOL_TH_008_case02_k6.inp
PU_S~112 OUT        820,943  06-01-01  6:40a PU_SOL_TH_008_case02_k6.out
PU_S~114 INP          1,561  05-29-01  3:56p PU_SOL_TH_008_case03_k6.inp
PU_S~116 OUT        825,181  06-01-01  6:55a PU_SOL_TH_008_case03_k6.out
PU_S~118 INP          1,561  05-29-01  3:56p PU_SOL_TH_008_case04_k6.inp
PU_S~120 OUT        832,211  06-01-01  7:09a PU_SOL_TH_008_case04_k6.out
       58 file(s)      24,027,562 bytes

Directory of D:\CASES\PC\AoA1\PST_011

.              <DIR>         10-04-01  2:06p .
.              <DIR>         10-04-01  2:06p .
PU_SOL~6 INP          3,221  05-29-01  4:08p PU_SOL_TH_011_C800_5_16_k6.inp
PU_SOL~8 INP          3,221  05-29-01  4:08p PU_SOL_TH_011_C800_3_16_k6.inp
PU_SO~10 INP          3,221  05-29-01  4:08p PU_SOL_TH_011_C800_4_16_k6.inp
PU_SO~12 INP          3,959  05-29-01  4:07p PU_SOL_TH_011_C800_7_18_k6.inp
PU_SO~14 INP          3,959  05-29-01  4:08p PU_SOL_TH_011_C800_5_18_k6.inp
PU_SO~16 INP          3,959  05-29-01  4:08p PU_SOL_TH_011_C800_3_18_k6.inp
PU_SO~18 INP          3,959  05-29-01  4:08p PU_SOL_TH_011_C800_4_18_k6.inp
PU_SO~20 INP          3,959  05-29-01  4:09p PU_SOL_TH_011_C800_6_18_k6.inp
PU_SO~22 OUT        750,934  05-31-01  4:25p PU_SOL_TH_011_C800_4_16_k6.out
PU_SO~24 OUT        745,332  05-31-01  4:39p PU_SOL_TH_011_C800_5_16_k6.out
PU_SO~26 OUT        743,710  05-31-01  4:10p PU_SOL_TH_011_C800_3_16_k6.out
PU_SO~28 OUT        760,850  05-31-01  4:34p PU_SOL_TH_011_C800_4_18_k6.out
PU_SO~30 OUT        752,779  05-31-01  4:55p PU_SOL_TH_011_C800_6_18_k6.out
PU_SO~32 OUT        760,669  05-31-01  5:04p PU_SOL_TH_011_C800_7_18_k6.out
PU_SO~34 OUT        757,132  05-31-01  4:48p PU_SOL_TH_011_C800_5_18_k6.out
PU_SO~36 OUT        758,864  05-31-01  4:20p PU_SOL_TH_011_C800_3_18_k6.out
PU_SO~38 INP          3,221  05-29-01  4:09p PU_SOL_TH_011_C800_1_16_k6.inp
PU_SO~40 OUT        744,560  05-31-01  3:40p PU_SOL_TH_011_C800_1_16_k6.out
PU_SO~42 INP          3,959  05-29-01  4:08p PU_SOL_TH_011_C800_1_18_k6.inp
PU_SO~44 OUT        759,250  05-31-01  3:50p PU_SOL_TH_011_C800_1_18_k6.out
```

```
PU_SO-46 INP          3,221  05-29-01  4:08p PU_SOL_TH_011_C800_2_16_k6.inp
PU_SO-48 OUT        747,789  05-31-01  3:55p PU_SOL_TH_011_C800_2_16_k6.out
PU_SO-50 INP          3,959  05-29-01  4:08p PU_SOL_TH_011_C800_2_18_k6.inp
PU_SO-52 OUT        756,582  05-31-01  4:05p PU_SOL_TH_011_C800_2_18_k6.out
        24 file(s)      9,082,269 bytes

Directory of D:\CASES\PC\AoA1\PST_014

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_19_k6.inp
PU_SOL-8 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_17_k6 inp
PU_SO-10 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_16_k6.inp
PU_SO-12 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_15_k6.inp
PU_SO-14 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_18_k6.inp
PU_SO-16 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_12_k6.inp
PU_SO-18 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_11_k6 inp
PU_SO-20 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_14_k6.inp
PU_SO-22 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_10_k6 inp
PU_SO-24 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_13_k6 inp
PU_SO-26 INP          6,715  05-30-01 11:15a PU_SOL_TH_014_29_k6.inp
PU_SO-28 INP          6,715  05-30-01 11:15a PU_SOL_TH_014_27_k6.inp
PU_SO-30 INP          6,715  05-30-01 11:15a PU_SOL_TH_014_26_k6.inp
PU_SO-32 INP          6,715  05-30-01 11:16a PU_SOL_TH_014_25_k6.inp
PU_SO-34 INP          6,715  05-30-01 11:15a PU_SOL_TH_014_28_k6.inp
PU_SO-36 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_22_k6.inp
PU_SO-38 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_21_k6.inp
PU_SO-40 INP          6,715  05-30-01 11:16a PU_SOL_TH_014_24_k6.inp
PU_SO-42 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_20_k6.inp
PU_SO-44 INP          6,633  05-30-01 11:16a PU_SOL_TH_014_23_k6.inp
PU_SO-46 INP          4,698  05-30-01 11:14a PU_SOL_TH_014_35_k6.inp
PU_SO-48 INP          6,750  05-30-01 11:15a PU_SOL_TH_014_32_k6.inp
PU_SO-50 INP          6,734  05-30-01 11:15a PU_SOL_TH_014_31_k6.inp
PU_SO-52 INP          6,753  05-30-01 11:15a PU_SOL_TH_014_34_k6.inp
PU_SO-54 INP          6,748  05-30-01 11:15a PU_SOL_TH_014_30_k6 inp
PU_SO-56 INP          6,717  05-30-01 11:15a PU_SOL_TH_014_33_k6.inp
PU_SO-58 INP          6,633  05-30-01 11:17a PU_SOL_TH_014_09_k6 inp
PU_SO-60 INP          6,633  05-30-01 11:14a PU_SOL_TH_014_07_k6 inp
PU_SO-62 INP          6,551  05-30-01 11:14a PU_SOL_TH_014_06_k6.inp
PU_SO-64 INP          6,551  05-30-01 11:14a PU_SOL_TH_014_05_k6.inp
PU_SO-66 INP          6,633  05-30-01 11:14a PU_SOL_TH_014_08_k6 inp
PU_SO-68 OUT        843,009  05-31-01  8:26p PU_SOL_TH_014_11_k6.out
PU_SO-70 OUT        842,492  05-31-01  9:24p PU_SOL_TH_014_14_k6.out
PU_SO-72 OUT        842,029  05-31-01  8:07p PU_SOL_TH_014_10_k6.out
PU_SO-74 OUT        842,846  05-31-01  9:05p PU_SOL_TH_014_13_k6.out
PU_SO-76 OUT        842,902  05-31-01  8:45p PU_SOL_TH_014_12_k6.out
PU_SO-78 OUT        842,986  05-31-01 11:38p PU_SOL_TH_014_21_k6.out
PU_SO-80 OUT        843,134  06-01-01 12:37a PU_SOL_TH_014_24_k6.out
PU_SO-82 OUT        841,973  05-31-01 11:19p PU_SOL_TH_014_20_k6.out
PU_SO-84 OUT        842,606  06-01-01 12:16a PU_SOL_TH_014_23_k6.out
PU_SO-86 OUT        842,807  05-31-01 11:57p PU_SOL_TH_014_22_k6.out
PU_SO-88 OUT        843,333  06-01-01  3:02a PU_SOL_TH_014_31_k6.out
PU_SO-90 OUT        844,041  06-01-01  4:04a PU_SOL_TH_014_34_k6.out
PU_SO-92 OUT        842,576  06-01-01  2:41a PU_SOL_TH_014_30_k6.out
PU_SO-94 OUT        843,572  06-01-01  3:43a PU_SOL_TH_014_33_k6.out
PU_SO-96 OUT        844,579  06-01-01  3:23a PU_SOL_TH_014_32_k6.out
PU_SO-98 OUT        842,666  05-31-01 11:00p PU_SOL_TH_014_19_k6.out
PU_S-100 OUT        842,373  05-31-01 10:21p PU_SOL_TH_014_17_k6.out
PU_S-102 OUT        842,926  05-31-01 10:02p PU_SOL_TH_014_16_k6.out
PU_S-104 OUT        843,709  05-31-01  9:43p PU_SOL_TH_014_15_k6.out
PU_S-106 OUT        845,453  05-31-01 10:40p PU_SOL_TH_014_18_k6.out
PU_S-108 OUT        843,543  06-01-01  2:20a PU_SOL_TH_014_29_k6 out
PU_S-110 OUT        845,154  06-01-01  1:39a PU_SOL_TH_014_27_k6 out
PU_S-112 OUT        843,087  06-01-01  1:18a PU_SOL_TH_014_26_k6 out
PU_S-114 OUT        843,233  06-01-01 12:58a PU_SOL_TH_014_25_k6.out
PU_S-116 OUT        843,197  06-01-01  1:59a PU_SOL_TH_014_28_k6 out
PU_S-118 OUT        841,728  06-01-01  4:25a PU_SOL_TH_014_35_k6.out
PU_S-120 OUT        843,043  05-31-01  7:48p PU_SOL_TH_014_09_k6 out
PU_S-122 OUT        842,571  05-31-01  7:10p PU_SOL_TH_014_07_k6.out
PU_S-124 OUT        843,181  05-31-01  6:50p PU_SOL_TH_014_06_k6.out
PU_S-126 OUT        842,375  05-31-01  6:33p PU_SOL_TH_014_05_k6.out
PU_S-128 OUT        843,337  05-31-01  7:29p PU_SOL_TH_014_08_k6 out
PU_S-130 INP          6,551  05-30-01 11:14a PU_SOL_TH_014_01_k6 inp
PU_S-132 OUT        841,771  05-31-01  5:22p PU_SOL_TH_014_01_k6 out
PU_S-134 INP          6,551  05-30-01 11:16a PU_SOL_TH_014_02_k6 inp
PU_S-136 OUT        841,900  05-31-01  5:40p PU_SOL_TH_014_02_k6.out
PU_S-138 INP          6,551  05-30-01 11:15a PU_SOL_TH_014_03_k6 inp
PU_S-140 OUT        842,217  05-31-01  5:58p PU_SOL_TH_014_03_k6.out
PU_S-142 INP          6,551  05-30-01 11:14a PU_SOL_TH_014_04_k6.inp
PU_S-144 OUT        842,233  05-31-01  6:15p PU_SOL_TH_014_04_k6.out
        70 file(s)     29,735,339 bytes

Directory of D:\CASES\PC\AoA1\PST_015

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 INP          6,714  05-30-01 11:19a PU_SOL_TH_015_17_k6.inp
PU_SOL-8 INP          6,714  05-30-01 11:19a PU_SOL_TH_015_16_k6.inp
PU_SO-10 INP          6,714  05-30-01 11:19a PU_SOL_TH_015_15_k6.inp
PU_SO-12 INP          6,632  05-30-01 11:19a PU_SOL_TH_015_12_k6.inp
PU_SO-14 INP          6,632  05-30-01 11:19a PU_SOL_TH_015_11_k6.inp
PU_SO-16 INP          6,632  05-30-01 11:19a PU_SOL_TH_015_14_k6.inp
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PU_SO~18 INP        6,632  05-30-01 11:19a PU_SOL_TH_015_10_k6 inp
PU_SO~20 INP        6,632  05-30-01 11:19a PU_SOL_TH_015_13_k6.inp
PU_SO~22 INP        6,632  05-30-01 11:20a PU_SOL_TH_015_09_k6.inp
PU_SO~24 INP        6,632  05-30-01 11:18a PU_SOL_TH_015_07_k6.inp
PU_SO~26 INP        6,468  05-30-01 11:18a PU_SOL_TH_015_06_k6 inp
PU_SO~28 INP        6,550  05-30-01 11:18a PU_SOL_TH_015_05_k6.inp
PU_SO~30 INP        6,632  05-30-01 11:18a PU_SOL_TH_015_08_k6.inp
PU_SO~32 OUT      845,491  06-01-01  7:41a PU_SOL_TH_015_11_k6 out
PU_SO~34 OUT      845,789  06-01-01  8:37a PU_SOL_TH_015_14_k6 out
PU_SO~36 OUT      845,195  06-01-01  7:22a PU_SOL_TH_015_10_k6 out
PU_SO~38 OUT      846,128  06-01-01  8:19a PU_SOL_TH_015_13_k6 out
PU_SO~40 OUT      845,704  06-01-01  8:00a PU_SOL_TH_015_12_k6.out
PU_SO~42 OUT      846,541  06-01-01  9:38a PU_SOL_TH_015_17_k6.out
PU_SO~44 OUT      847,128  06-01-01  9:18a PU_SOL_TH_015_16_k6.out
PU_SO~46 OUT      845,939  06-01-01  8:58a PU_SOL_TH_015_15_k6.out
PU_SO~48 OUT      846,146  06-01-01  7:04a PU_SOL_TH_015_09_k6.out
PU_SO~50 OUT      846,077  06-01-01  6:26a PU_SOL_TH_015_07_k6.out
PU_SO~52 OUT      843,437  06-01-01  6:07a PU_SOL_TH_015_06_k6.out
PU_SO~54 OUT      845,445  06-01-01  5:51a PU_SOL_TH_015_05_k6.out
PU_SO~56 OUT      845,635  06-01-01  6:45a PU_SOL_TH_015_08_k6.out
PU_SO~58 INP        6,550  05-30-01 11:18a PU_SOL_TH_015_01_k6.inp
PU_SO~60 OUT      831,314  06-01-01  4:42a PU_SOL_TH_015_01_k6.out
PU_SO~62 INP        6,550  05-30-01 11:19a PU_SOL_TH_015_02_k6.inp
PU_SO~64 OUT      843,969  06-01-01  5:00a PU_SOL_TH_015_02_k6.out
PU_SO~66 INP        6,550  05-30-01 11:19a PU_SOL_TH_015_03_k6.inp
PU_SO~68 OUT      844,700  06-01-01  5:17a PU_SOL_TH_015_03_k6.out
PU_SO~70 INP        6,550  05-30-01 11:18a PU_SOL_TH_015_04_k6.inp
PU_SO~72 OUT      845,212  06-01-01  5:34a PU_SOL_TH_015_04_k6.out
        34 file(s)     14,472,266 bytes

Directory of D:\CASES\PC\AoA1\PST_016

.             <DIR>        10-04-01  2:06p .
..            <DIR>        10-04-01  2:06p .
PU_SOL~6 INP        6,715  05-30-01 11:21a PU_SOL_TH_016_09_k6.inp
PU_SOL~8 INP        6,879  05-30-01 11:21a PU_SOL_TH_016_07_k6.inp
PU_SO~10 INP        6,879  05-30-01 11:21a PU_SOL_TH_016_06_k6.inp
PU_SO~12 INP        6,879  05-30-01 11:21a PU_SOL_TH_016_05_k6.inp
PU_SO~14 INP        6,879  05-30-01 11:21a PU_SOL_TH_016_08_k6.inp
PU_SO~16 INP        6,715  05-30-01 11:21a PU_SOL_TH_016_11_k6.inp
PU_SO~18 INP        6,715  05-30-01 11:21a PU_SOL_TH_016_10_k6.inp
PU_SO~20 OUT      826,389  06-01-01 10:41a PU_SOL_TH_016_11_k6.out
PU_SO~22 OUT      824,532  06-01-01 10:34a PU_SOL_TH_016_10_k6.out
PU_SO~24 OUT      824,513  06-01-01 10:28a PU_SOL_TH_016_09_k6 out
PU_SO~26 OUT      816,088  06-01-01 10:15a PU_SOL_TH_016_07_k6 out
PU_SO~28 OUT      815,888  06-01-01 10:10a PU_SOL_TH_016_06_k6 out
PU_SO~30 OUT      812,582  06-01-01 10:04a PU_SOL_TH_016_05_k6 out
PU_SO~32 OUT      816,588  06-01-01 10:21a PU_SOL_TH_016_08_k6.out
PU_SO~34 INP        6,879  05-30-01 11:20a PU_SOL_TH_016_01_k6 inp
PU_SO~36 OUT      813,801  06-01-01  9:43a PU_SOL_TH_016_01_k6 out
PU_SO~38 INP        6,879  05-30-01 11:21a PU_SOL_TH_016_02_k6 inp
PU_SO~40 OUT      810,155  06-01-01  9:48a PU_SOL_TH_016_02_k6 out
PU_SO~42 INP        6,879  05-30-01 11:21a PU_SOL_TH_016_03_k6 inp
PU_SO~44 OUT      811,360  06-01-01  9:53a PU_SOL_TH_016_03_k6 out
PU_SO~46 INP        6,961  05-30-01 11:21a PU_SOL_TH_016_04_k6.inp
PU_SO~48 OUT      811,104  06-01-01  9:58a PU_SOL_TH_016_04_k6 out
        22 file(s)      9,058,259 bytes

Directory of D:\CASES\PC\AoA1\PST_017

.             <DIR>        10-04-01  2:06p .
.             <DIR>        10-04-01  2:06p ..
PU_SOL~6 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_09_k6.inp
PU_SOL~8 INP        6,879  05-30-01 11:22a PU_SOL_TH_017_07_k6.inp
PU_SO~10 INP        6,879  05-30-01 11:22a PU_SOL_TH_017_06_k6.inp
PU_SO~12 INP        6,879  05-30-01 11:22a PU_SOL_TH_017_05_k6.inp
PU_SO~14 INP        6,879  05-30-01 11:22a PU_SOL_TH_017_08_k6.inp
PU_SO~16 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_17_k6.inp
PU_SO~18 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_16_k6.inp
PU_SO~20 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_15_k6.inp
PU_SO~22 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_18_k6.inp
PU_SO~24 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_12_k6.inp
PU_SO~26 INP        6,551  05-30-01 11:23a PU_SOL_TH_017_11_k6.inp
PU_SO~28 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_14_k6.inp
PU_SO~30 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_10_k6.inp
PU_SO~32 INP        6,879  05-30-01 11:23a PU_SOL_TH_017_13_k6.inp
PU_SO~34 OUT      813,431  06-01-01 10:17a PU_SOL_TH_017_11_k6 out
PU_SO~36 OUT      813,585  06-01-01 10:35a PU_SOL_TH_017_14_k6.out
PU_SO~38 OUT      814,406  06-01-01 10:11a PU_SOL_TH_017_10_k6 out
PU_SO~40 OUT      813,546  06-01-01 10:29a PU_SOL_TH_017_13_k6 out
PU_SO~42 OUT      814,647  06-01-01 10:23a PU_SOL_TH_017_12_k6 out
PU_SO~44 OUT      814,063  06-01-01 10:05a PU_SOL_TH_017_09_k6 out
PU_SO~46 OUT      813,757  06-01-01  9:54a PU_SOL_TH_017_07_k6 out
PU_SO~48 OUT      813,330  06-01-01  9:48a PU_SOL_TH_017_06_k6.out
PU_SO~50 OUT      813,367  06-01-01  9:43a PU_SOL_TH_017_05_k6.out
PU_SO~52 OUT      813,509  06-01-01 10:00a PU_SOL_TH_017_08_k6.out
PU_SO~54 OUT      814,303  06-01-01 10:52a PU_SOL_TH_017_17_k6.out
PU_SO~56 OUT      813,316  06-01-01 10:47a PU_SOL_TH_017_16_k6.out
PU_SO~58 OUT      813,378  06-01-01 10:41a PU_SOL_TH_017_15_k6.out
PU_SO~60 OUT      813,431  06-01-01 10:58a PU_SOL_TH_017_18_k6.out
PU_SO~62 INP        6,551  05-30-01 11:22a PU_SOL_TH_017_01_k6.inp
PU_SO~64 OUT      812,775  06-01-01  9:21a PU_SOL_TH_017_01_k6.out
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PU_SO~66 INP          6,879  05-30-01 11:22a PU_SOL_TH_017_02_k6.inp
PU_SO~68 OUT        813,845  06-01-01  9:26a PU_SOL_TH_017_02_k6.out
PU_SO~70 INP          6,879  05-30-01 11:22a PU_SOL_TH_017_03_k6.inp
PU_SO~72 OUT        813,625  06-01-01  9:32a PU_SOL_TH_017_03_k6.out
PU_SO~74 INP          6,879  05-30-01 11:22a PU_SOL_TH_017_04_k6.inp
PU_SO~76 OUT        814,250  06-01-01  9:37a PU_SOL_TH_017_04_k6.out
        36 file(s)     14,769,730 bytes

Directory of D:\CASES\PC\AoA1\PST_020

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
PU_SOL~6 INP          5,953  05-30-01  8:05a PU_SOL_TH_020_06_T8A_k6.inp
PU_SOL~8 INP          5,953  05-30-01  8:05a PU_SOL_TH_020_07_T8A_k6.inp
PU_SO~10 INP          6,691  05-30-01  8:05a PU_SOL_TH_020_08_T8A_k6.inp
PU_SO~12 INP          6,691  05-30-01  8:04a PU_SOL_TH_020_09_T8A_k6.inp
PU_SO~14 OUT        811,258  06-01-01  1:40p PU_SOL_TH_020_08_T8A_k6.out
PU_SO~16 INP          5,953  05-30-01  8:05a PU_SOL_TH_020_12_T8B_k6.inp
PU_SO~18 OUT        810,496  06-01-01  2:04p PU_SOL_TH_020_09_T8A_k6.out
PU_SO~20 INP          5,953  05-30-01  8:04a PU_SOL_TH_020_13_T8B_k6.inp
PU_SO~22 OUT        801,154  06-01-01 12:51p PU_SOL_TH_020_06_T8A_k6.out
PU_SO~24 INP          6,691  05-30-01  8:05a PU_SOL_TH_020_14_T8B_k6.inp
PU_SO~26 INP          5,953  05-30-01  8:04a PU_SOL_TH_020_10_T8B_k6.inp
PU_SO~28 OUT        799,761  06-01-01  1:18p PU_SOL_TH_020_07_T8A_k6.out
PU_SO~30 INP          6,691  05-30-01  8:05a PU_SOL_TH_020_15_T8B_k6.inp
PU_SO~32 INP          5,953  05-30-01  8:04a PU_SOL_TH_020_11_T8B_k6.inp
PU_SO~34 OUT        809,983  06-01-01  4:11p PU_SOL_TH_020_14_T8B_k6.out
PU_SO~36 OUT        800,426  06-01-01  2:30p PU_SOL_TH_020_10_T8B_k6.out
PU_SO~38 OUT        813,938  06-01-01  4:34p PU_SOL_TH_020_15_T8B_k6.out
PU_SO~40 OUT        801,397  06-01-01  2:57p PU_SOL_TH_020_11_T8B_k6.out
PU_SO~42 OUT        802,884  06-01-01  3:23p PU_SOL_TH_020_12_T8B_k6.out
PU_SO~44 OUT        801,048  06-01-01  3:48p PU_SOL_TH_020_13_T8B_k6.out
PU_SO~46 INP          5,951  06-06-01  3:20p PU_SOL_TH_020_01_T8A_k6.inp
PU_SO~48 OUT        493,523  06-06-01  3:45p PU_SOL_TH_020_01_T8A_k6.out
PU_SO~50 INP          5,953  05-30-01  8:05a PU_SOL_TH_020_02_T8A_k6.inp
PU_SO~52 OUT        800,092  06-01-01 11:33a PU_SOL_TH_020_02_T8A_k6.out
PU_SO~54 INP          5,953  05-30-01  8:05a PU_SOL_TH_020_03_T8A_k6.inp
PU_SO~56 OUT        802,537  06-01-01 12:01p PU_SOL_TH_020_03_T8A_k6.out
PU_SO~58 INP          5,953  05-30-01  8:05a PU_SOL_TH_020_05_T8A_k6.inp
PU_SO~60 OUT        801,805  06-01-01 12:26p PU_SOL_TH_020_05_T8A_k6.out
        28 file(s)     11,036,594 bytes

Directory of D:\CASES\PC\AoA1\PST_025

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
PSTH02~6 INP          8,250  08-22-01  1:06p psth025_case3_c6.inp
PSTH02~8 INP          8,250  08-23-01  4:03p psth025_case4_c6.inp
PSTH0~10 INP          8,250  08-22-01  1:06p psth025_case5_c6.inp
PSTH0~12 INP          8,250  08-22-01  1:06p psth025_case6_c6.inp
PSTH0~14 GIF          2,193  08-23-01  4:20a psth025_case3_c6.plot0001.gif
PSTH0~16 GIF          2,064  08-23-01  4:20a psth025_case3_c6.plot0000.gif
PSTH0~18 GIF          2,180  08-23-01 11:14p psth025_case4_c6.plot0001.gif
PSTH0~20 GIF          2,054  08-23-01 11:14p psth025_case4_c6.plot0000.gif
PSTH0~22 GIF          2,176  08-23-01  9:03a psth025_case5_c6.plot0001.gif
PSTH0~24 GIF          2,061  08-23-01  9:03a psth025_case5_c6.plot0000.gif
PSTH0~26 GIF          2,188  08-24-01  3:57a psth025_case6_c6.plot0001.gif
PSTH0~28 GIF          2,062  08-24-01  3:57a psth025_case6_c6.plot0000.gif
PSTH0~30 OUT        989,570  08-23-01  9:03a psth025_case5_c6.out
PSTH0~32 OUT        989,461  08-24-01  3:57a psth025_case6_c6.out
PSTH0~34 GIF          2,068  08-22-01 10:56a psth025_case1_c6.plot0000.gif
PSTH0~36 INP          1,813  08-21-01  4:38p psth025_case1_c5toc6.inp
PSTH0~38 OUT        988,969  08-22-01 10:56a psth025_case1_c6.out
PSTH0~40 TXT          1,754  08-21-01  4:34p psth025_case1_c5.txt
PSTH0~42 GIF          2,161  08-22-01 10:56a psth025_case1_c6.plot0001.gif
PSTH0~44 INP          8,250  08-21-01  7:13p psth025_case1_c6.inp
PSTH0~46 OUT        988,625  08-22-01 11:38p psth025_case2_c6.out
PSTH0~48 GIF          2,054  08-22-01 11:38p psth025_case2_c6.plot0000.gif
PSTH0~50 INP          8,247  08-21-01  4:40p psth025_case1_c6_NEA inp
PSTH0~52 OUT        989,463  08-23-01  4:20a psth025_case3_c6.out
PSTH0~54 GIF          2,191  08-22-01 11:38p psth025_case2_c6.plot0001.gif
PSTH0~56 INP          8,250  08-22-01  1:06p psth025_case2_c6.inp
PSTH0~58 OUT        989,412  08-23-01 11:14p psth025_case4_c6.out
        27 file(s)      6,022,266 bytes

Directory of D:\CASES\PC\AoA1\PST_026

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PSTH02~6 OUT         47,651  08-21-01  7:10p psth026_case3_c5toc6.out
PSTH02~8 GIF          2,069  08-22-01  6:13a psth026_case3_c6.plot0001.gif
PSTH0~10 INP         10,544  08-21-01  7:12p psth026_case3_c6.inp
PSTH0~12 GIF          1,897  08-22-01  6:13a psth026_case3_c6.plot0000.gif
PSTH0~14 OUT      1,029,352  08-22-01  6:13a psth026_case3_c6.out
PSTH0~16 INP          2,234  08-21-01  7:08p psth026_case3_c5toc6.inp
PSTH0~18 GIF          1,907  08-21-01 10:54p psth026_case1_c6.plot0000.gif
PSTH0~20 INP          2,234  08-21-01  7:06p psth026_case1_c5toc6.inp
PSTH0~22 OUT         47,651  08-21-01  7:10p psth026_case1_c5toc6 out
PSTH0~24 TXT          2,222  08-21-01  7:02p psth026_case1_c5.txt
PSTH0~26 GIF          2,069  08-21-01 10:54p psth026_case1_c6.plot0001.gif
PSTH0~28 INP         10,544  08-21-01  7:12p psth026_case1_c6 inp
PSTH0~30 OUT      1,023,990  08-21-01 10:54p psth026_case1_c6 out
```

```
PSTH0~32 TXT          2,222  08-21-01  7:01p psth026_case2_c5.txt
PSTH0~34 GIF          1,907  08-22-01  2:34a psth026_case2_c6.plot0000 gif
PSTH0~36 INP          2,234  08-21-01  7:09p psth026_case2_c5toc6.inp
PSTH0~38 OUT         47,651  08-21-01  7:10p psth026_case2_c5toc6.out
PSTH0~40 TXT          2,222  08-21-01  7:03p psth026_case3_c5 txt
PSTH0~42 GIF          2,069  08-22-01  2:34a psth026_case2_c6.plot0001 gif
PSTH0~44 INP         10,544  08-21-01  7:12p psth026_case2_c6 inp
PSTH0~46 OUT      1,022,828  08-22-01  2:34a psth026_case2_c6 out
        21 file(s)      3,276,041 bytes

Directory of D:\CASES\PC\AoA1\usl

.              <DIR>        10-04-01  2:06p
..             <DIR>        10-04-01  2:06p ..
CONCRE~5       <DIR>        10-04-01  2:06p Concrete Reflector
FULLSE~7       <DIR>        10-04-01  2:06p Full Set
PUCONT~9       <DIR>        10-04-01  2:06p Pu content
WATER~11       <DIR>        10-04-01  2:06p Water Cadmium Reflector
WATER~13       <DIR>        10-04-01  2:06p Water Reflector
         0 file(s)              0 bytes

Directory of D:\CASES\PC\AoA1\usl\Concrete Reflector

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU-NIT~6 INP          911  09-25-01 10:32a Pu-Nitrite_Concrete_Reflector_EALF inp
PU-NIT~8 OUT        5,122  09-25-01 10:34a Pu-Nitrite_Concrete_Reflector_EALF out
         2 file(s)          6,033 bytes

Directory of D:\CASES\PC\AoA1\usl\Full Set

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU-NIT~6 INP        6,042  09-24-01  2:01p Pu-Nitrite-EALF.inp
PU-NIT~8 OUT       13,566  09-24-01  2:03p Pu-Nitrite-EALF.out
PU-NI~10 INP        5,599  09-24-01  2:03p Pu-Nitrite-HPu.inp
PU-NI~12 OUT       13,566  09-24-01  2:05p Pu-Nitrite-HPu.out
REDUC~14 INP        5,757  09-24-01  4:29p reduced_set_162_exp inp
REDUC~16 OUT       12,047  09-24-01  4:31p reduced_set_162_exp out
         6 file(s)         56,577 bytes

Directory of D:\CASES\PC\AoA1\usl\Pu content

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU-NIT~6 INP        1,211  09-24-01  2:09p Pu-Nitrite-Pu.inp
PU-NIT~8 OUT        5,956  09-24-01  2:10p Pu-Nitrite-Pu.out
         2 file(s)          7,167 bytes

Directory of D:\CASES\PC\AoA1\usl\Water Cadmium Reflector

               <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
         0 file(s)              0 bytes

Directory of D:\CASES\PC\AoA1\usl\Water Reflector

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
         0 file(s)              0 bytes

Directory of D:\CASES\PC\AoA2

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
MCT_002        <DIR>        10-04-01  2:06p MCT_002
MCT_003        <DIR>        10-04-01  2:06p MCT_003
MCT_004        <DIR>        10-04-01  2:06p MCT_004
MCT_005        <DIR>        10-04-01  2:06p MCT_005
MCT_009        <DIR>        10-04-01  2:06p MCT_009
USL            <DIR>        10-04-01  2:06p usl
         0 file(s)              0 bytes

Directory of D:\CASES\PC\AoA2\MCT_002

.              <DIR>        10-04-01  2:06p .
 .             <DIR>        10-04-01  2:06p ..
MIX_CO~6 INP       25,223  05-30-01 10:51a MIX_COMP_THERM_002_PNL35_k6.inp
MIX_CO~8 INP       25,223  05-30-01 10:52a MIX_COMP_THERM_002_PNL34_k6.inp
MIX_C~10 OUT    1,037,434  05-31-01  8:10a MIX_COMP_THERM_002_PNL35_k6 out
MIX_C~12 OUT    1,016,579  05-31-01  7:17a MIX_COMP_THERM_002_PNL34_k6 out
MIX_C~14 INP       25,223  05-30-01 10:52a MIX_COMP_THERM_002_PNL30_k6.inp
MIX_C~16 OUT    1,023,755  05-30-01  2:00p MIX_COMP_THERM_002_PNL30_k6.out
MIX_C~18 INP       25,223  05-30-01 10:51a MIX_COMP_THERM_002_PNL31_k6.inp
MIX_C~20 OUT    1,043,498  05-30-01  2:51p MIX_COMP_THERM_002_PNL31_k6.out
MIX_C~22 INP       25,223  05-30-01 10:52a MIX_COMP_THERM_002_PNL32_k6.inp
MIX_C~24 OUT    1,016,958  05-30-01  4:10p MIX_COMP_THERM_002_PNL32_k6.out
MIX_C~26 INP       25,223  05-30-01 10:51a MIX_COMP_THERM_002_PNL33_k6.inp
MIX_C~28 OUT    1,034,110  05-30-01  4:57p MIX_COMP_THERM_002_PNL33_k6.out
        12 file(s)      6,323,672 bytes

Directory of D:\CASES\PC\AoA2\MCT_003
```

```
.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
MIX_CO~6 OUT     1,013,112  05-31-01  4:26p MIX_COMP_THERM_003_cas4_k6.out
MIX_CO~8 OUT     1,008,733  05-31-01  5:59p MIX_COMP_THERM_003_cas5_k6.out
MIX_C~10 OUT     1,010,552  05-31-01  7:39p MIX_COMP_THERM_003_cas6_k6 out
MIX_C~12 INP        23,666  05-30-01 10:58a MIX_COMP_THERM_003_cas4_k6.inp
MIX_C~14 INP        23,666  05-30-01 10:58a MIX_COMP_THERM_003_cas5_k6.inp
MIX_C~16 INP        23,666  05-30-01 10:58a MIX_COMP_THERM_003_cas6_k6.inp
MIX_C~18 INP        23,666  05-30-01 10:56a MIX_COMP_THERM_003_cas1_k6.inp
MIX_C~20 OUT     1,010,990  05-31-01 10:46a MIX_COMP_THERM_003_cas1_k6.out
MIX_C~22 INP        23,666  05-30-01 10:57a MIX_COMP_THERM_003_cas2-1_k6.inp
MIX_C~24 OUT     1,015,766  05-31-01 12:11p MIX_COMP_THERM_003_cas2-1_k6.out
MIX_C~26 INP        23,666  05-30-01 10:57a MIX_COMP_THERM_003_cas2-2_k6.inp
MIX_C~28 OUT     1,014,981  05-31-01  1:36p MIX_COMP_THERM_003_cas2-2_k6.out
MIX_C~30 INP        23,830  05-30-01 10:58a MIX_COMP_THERM_003_cas3_k6.inp
MIX_C~32 OUT     1,016,672  05-31-01  2:50p MIX_COMP_THERM_003_cas3_k6.out
        14 file(s)      7,256,632 bytes

Directory of D:\CASES\PC\AoA2\MCT_004

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
MIX_CO~6 INP        21,704  05-30-01 11:01a MIX_COMP_THERM_004_cas05_k6.inp
MIX_CO~8 INP        21,704  05-30-01 10:59a MIX_COMP_THERM_004_cas10_k6.inp
MIX_C~10 INP        21,704  05-30-01 10:59a MIX_COMP_THERM_004_cas11_k6.inp
MIX_C~12 INP        21,704  05-30-01 11:01a MIX_COMP_THERM_004_cas08_k6.inp
MIX_C~14 INP        21,704  05-30-01 11:01a MIX_COMP_THERM_004_cas07_k6.inp
MIX_C~16 INP        21,704  05-30-01 11:01a MIX_COMP_THERM_004_cas06_k6.inp
MIX_C~18 INP        21,704  05-30-01 11:02a MIX_COMP_THERM_004_cas09_k6.inp
MIX_C~20 OUT     1,130,763  06-01-01  7:04a MIX_COMP_THERM_004_cas08_k6.out
MIX_C~22 OUT     1,130,696  06-01-01  5:35a MIX_COMP_THERM_004_cas07_k6.out
MIX_C~24 OUT     1,131,072  06-01-01  4:06a MIX_COMP_THERM_004_cas06_k6.out
MIX_C~26 OUT     1,130,707  06-01-01  8:34a MIX_COMP_THERM_004_cas09_k6.out
MIX_C~28 OUT     1,131,850  06-01-01  2:41a MIX_COMP_THERM_004_cas05_k6.out
MIX_C~30 OUT     1,131,403  06-01-01 10:07a MIX_COMP_THERM_004_cas10_k6 out
MIX_C~32 OUT     1,131,388  06-01-01 11:40a MIX_COMP_THERM_004_cas11_k6 out
MIX_C~34 INP        21,704  05-30-01 10:59a MIX_COMP_THERM_004_cas01_k6.inp
MIX_C~36 OUT     1,132,379  05-31-01  9:03p MIX_COMP_THERM_004_cas01_k6 out
MIX_C~38 INP        21,700  05-30-01 11:00a MIX_COMP_THERM_004_cas02_k6.inp
MIX_C~40 OUT     1,133,040  05-31-01 10:26p MIX_COMP_THERM_004_cas02_k6 out
MIX_C~42 INP        21,704  05-30-01 11:00a MIX_COMP_THERM_004_cas03_k6.inp
MIX_C~44 OUT     1,133,002  05-31-01 11:49p MIX_COMP_THERM_004_cas03_k6 out
MIX_C~46 INP        21,704  05-30-01 11:00a MIX_COMP_THERM_004_cas04_k6.inp
MIX_C~48 OUT     1,131,131  06-01-01  1:15a MIX_COMP_THERM_004_cas04_k6 out
        22 file(s)     12,686,171 bytes

Directory of D:\CASES\PC\AoA2\MCT_005

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p  .
MIXCT_~6 INP        92,572  05-30-01 11:03a mixct_005_case5_k6.inp
MIXCT_~8 INP        92,572  05-30-01 11:03a mixct_005_case6_k6.inp
MIXCT~10 OUT     1,399,151  06-02-01  2:31a mixct_005_case5_k6.out
MIXCT~12 OUT     1,394,434  06-02-01  5:38a mixct_005_case6_k6.out
MIXCT~14 INP        92,735  08-30-01  5:48p mixct_005_case1_k6.inp
MIXCT~16 OUT     1,404,842  08-30-01 10:52p mixct_005_case1_k6 out
MIXCT~18 INP        92,763  05-30-01 11:02a mixct_005_case2_k6.inp
MIXCT~20 OUT     1,410,062  06-01-01  6:22p mixct_005_case2_k6 out
MIXCT~22 INP        92,572  05-30-01 11:03a mixct_005_case3_k6 inp
MIXCT~24 OUT     1,405,905  06-01-01  8:34p mixct_005_case3_k6 out
MIXCT~26 INP        92,572  05-30-01 11:03a mixct_005_case4_k6.inp
MIXCT~28 OUT     1,404,528  06-01-01 11:11p mixct_005_case4_k6 out
        12 file(s)      8,974,708 bytes

Directory of D:\CASES\PC\AoA2\MCT_009

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
MIXCT_~6 INP       145,340  05-30-01 11:04a mixct_009_case5_k6 inp
MIXCT_~8 INP       145,318  05-30-01 11:05a mixct_009_case6_k6 inp
MIXCT~10 OUT     1,706,982  06-01-01  9:55p mixct_009_case5_k6.out
MIXCT~12 OUT     1,715,630  06-01-01 10:58p mixct_009_case6_k6 out
MIXCT~14 INP       146,078  05-30-01 11:04a mixct_009_case1_k6.inp
MIXCT~16 OUT     1,713,599  06-01-01  5:55p mixct_009_case1_k6 out
MIXCT~18 INP       145,564  05-30-01 11:05a mixct_009_case2_k6 inp
MIXCT~20 OUT     1,716,847  06-01-01  6:54p mixct_009_case2_k6.out
MIXCT~22 INP       145,362  05-30-01 11:04a mixct_009_case3_k6 inp
MIXCT~24 OUT     1,704,225  06-01-01  7:52p mixct_009_case3_k6 out
MIXCT~26 INP       145,236  05-30-01 11:04a mixct_009_case4_k6.inp
MIXCT~28 OUT     1,715,819  06-01-01  8:52p mixct_009_case4_k6.out
        12 file(s)     11,146,000 bytes

Directory of D:\CASES\PC\AoA2\usl

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
FULLSE~5       <DIR>        10-04-01  2:06p Full Set
         0 file(s)              0 bytes

Directory of D:\CASES\PC\AoA2\usl\Full Set
```

```
               <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
MIX_FU-6 INP        1,104  09-24-01  3:10p MIX_Full_Set_EALF.inp
MIX_FU-8 OUT        5,407  09-24-01  3:17p MIX_Full_Set_EALF.out
MIX_F-10 INP        1,297  09-24-01  3:09p MIX_Full_Set_PuO2.inp
MIX_F-12 OUT        5,407  09-24-01  3:18p MIX_Full_Set_PuO2.out
MIX_F-14 INP        1,113  09-24-01  3:15p MIX_Full_Set_VmVf.inp
MIX_F-16 OUT        5,619  09-24-01  3:16p MIX_Full_Set_VmVf.out
         6 file(s)         19,947 bytes

Directory of D:\CASES\Sun

               <DIR>        10-04-01  2:06p .
 .             <DIR>        10-04-01  2:06p ..
AOA1           <DIR>        10-04-01  2:06p AoA1
AOA2           <DIR>        10-04-01  2:06p AoA2
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1

.              <DIR>        10-04-01  2:06p .
 .             <DIR>        10-04-01  2:06p ..
PST_001        <DIR>        10-04-01  2:06p PST_001
PST_002        <DIR>        10-04-01  2:06p PST_002
PST_003        <DIR>        10-04-01  2:06p PST_003
PST_004        <DIR>        10-04-01  2:06p PST_004
PST_005        <DIR>        10-04-01  2:06p PST_005
PST_006        <DIR>        10-04-01  2:06p PST_006
PST_008        <DIR>        10-04-01  2:06p PST_008
PST_011        <DIR>        10-04-01  2:06p PST_011
PST_014        <DIR>        10-04-01  2:06p PST_014
PST_015        <DIR>        10-04-01  2:06p PST_015
PST_016        <DIR>        10-04-01  2:06p PST_016
PST_017        <DIR>        10-04-01  2:06p PST_017
PST_020        <DIR>        10-04-01  2:06p PST_020
PST_025        <DIR>        10-04-01  2:06p PST_025
PST_026        <DIR>        10-04-01  2:06p PST_026
PU_SO-35       <DIR>        10-04-01  2:06p PU_SOL_THERM
USL            <DIR>        10-04-01  2:06p usl
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_001

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
001_INP        <DIR>        10-04-01  2:06p 001_INP
001_OUT        <DIR>        10-04-01  2:06p 001_OUT
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_001\001_INP

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6            4,311  03-30-01 10:08a PU_SOL_TH_001_6_T8A_k6
PU_SOL-8            4,311  03-30-01 10:08a PU_SOL_TH_001_5_T8A_k6
PU_SO-10            4,311  03-30-01 10:08a PU_SOL_TH_001_1_T8A_k6
PU_SO-12            4,311  03-30-01 10:08a PU_SOL_TH_001_2_T8A_k6
PU_SO-14            4,311  03-30-01 10:08a PU_SOL_TH_001_3_T8A_k6
PU_SO-16            4,311  03-30-01 10:08a PU_SOL_TH_001_4_T8A_k6
         6 file(s)         25,866 bytes

Directory of D:\CASES\Sun\AoA1\PST_001\001_OUT

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 OUT      509,114  03-30-01 10:08a PU_SOL_TH_001_5_T8A_k6.out
PU_SOL-8 OUT      506,625  03-30-01 10:08a PU_SOL_TH_001_6_T8A_k6 out
PU_SO-10 OUT      505,514  03-30-01 10:08a PU_SOL_TH_001_1_T8A_k6 out
PU_SO-12 OUT      506,385  03-30-01 10:08a PU_SOL_TH_001_2_T8A_k6.out
PU_SO-14 OUT      505,604  03-30-01 10:08a PU_SOL_TH_001_3_T8A_k6 out
PU_SO-16 OUT      513,418  03-30-01 10:08a PU_SOL_TH_001_4_T8A_k6.out
         6 file(s)      3,046,660 bytes

Directory of D:\CASES\Sun\AoA1\PST_002

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
002_INP        <DIR>        10-04-01  2:06p 002_inp
002_OUT        <DIR>        10-04-01  2:06p 002_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_002\002_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6            4,065  03-30-01 10:08a PU_SOL_TH_002_5_k6
PU_SOL-8            4,065  03-30-01 10:08a PU_SOL_TH_002_7_k6
PU_SO-10            4,065  03-30-01 10:08a PU_SOL_TH_002_6_k6
PU_SO-12            4,065  03-30-01 10:08a PU_SOL_TH_002_1_k6
PU_SO-14            4,065  03-30-01 10:08a PU_SOL_TH_002_2_k6
PU_SO-16            4,065  03-30-01 10:08a PU_SOL_TH_002_3_k6
PU_SO-18            4,065  03-30-01 10:08a PU_SOL_TH_002_4_k6
```

```
        7 file(s)        28,455 bytes

Directory of D:\CASES\Sun\AoA1\PST_002\002_out

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6 OUT       474,734  03-30-01 10:08a PU_SOL_TH_002_5_k6 out
PU_SOL~8 OUT       477,965  03-30-01 10:08a PU_SOL_TH_002_6_k6 out
PU_SO~10 OUT       479,903  03-30-01 10:08a PU_SOL_TH_002_7_k6 out
PU_SO~12 OUT       483,825  03-30-01 10:08a PU_SOL_TH_002_1_k6 out
PU_SO~14 OUT       476,325  03-30-01 10:08a PU_SOL_TH_002_2_k6 out
PU_SO~16 OUT       474,751  03-30-01 10:08a PU_SOL_TH_002_3_k6 out
PU_SO~18 OUT       477,309  03-30-01 10:08a PU_SOL_TH_002_4_k6 out
        7 file(s)      3,344,812 bytes

Directory of D:\CASES\Sun\AoA1\PST_003

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
003_INP        <DIR>        10-04-01  2:06p 003_inp
003_OUT        <DIR>        10-04-01  2:06p 003_out
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_003\003_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6             4,475  03-30-01 10:08a PU_SOL_TH_003_6_k6
PU_SOL~8             4,475  03-30-01 10:08a PU_SOL_TH_003_8_k6
PU_SO~10             4,475  03-30-01 10:08a PU_SOL_TH_003_5_k6
PU_SO~12             4,475  03-30-01 10:08a PU_SOL_TH_003_7_k6
PU_SO~14             4,475  03-30-01 10:08a PU_SOL_TH_003_1_k6
PU_SO~16             4,475  03-30-01 10:08a PU_SOL_TH_003_2_k6
PU_SO~18             4,475  03-30-01 10:08a PU_SOL_TH_003_3_k6
PU_SO~20             4,475  03-30-01 10:08a PU_SOL_TH_003_4_k6
        8 file(s)         35,800 bytes

Directory of D:\CASES\Sun\AoA1\PST_003\003_out

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6 OUT       502,223  03-30-01 10:08a PU_SOL_TH_003_5_k6 out
PU_SOL~8 OUT       491,381  03-30-01 10:08a PU_SOL_TH_003_6_k6 out
PU_SO~10 OUT       498,887  03-30-01 10:08a PU_SOL_TH_003_7_k6 out
PU_SO~12 OUT       499,680  03-30-01 10:08a PU_SOL_TH_003_8_k6 out
PU_SO~14 OUT       498,323  03-30-01 10:08a PU_SOL_TH_003_1_k6 out
PU_SO~16 OUT       502,936  03-30-01 10:08a PU_SOL_TH_003_2_k6.out
PU_SO~18 OUT       496,892  03-30-01 10:08a PU_SOL_TH_003_3_k6.out
PU_SO~20 OUT       498,300  03-30-01 10:08a PU_SOL_TH_003_4_k6.out
        8 file(s)      3,988,622 bytes

Directory of D:\CASES\Sun\AoA1\PST_004

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
004_INP        <DIR>        10-04-01  2:06p 004_inp
004_OUT        <DIR>        10-04-01  2:06p 004_out
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_004\004_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6             4,065  03-30-01 10:08a PU_SOL_TH_004_2_k6
PU_SOL~8             4,065  03-30-01 10:08a PU_SOL_TH_004_4_k6
PU_SO~10             4,065  03-30-01 10:08a PU_SOL_TH_004_6_k6
PU_SO~12             4,065  03-30-01 10:08a PU_SOL_TH_004_8_k6
PU_SO~14             4,065  03-30-01 10:08a PU_SOL_TH_004_1_k6
PU_SO~16             4,065  03-30-01 10:08a PU_SOL_TH_004_3_k6
PU_SO~18             4,065  03-30-01 10:08a PU_SOL_TH_004_5_k6
PU_SO~20             4,065  03-30-01 10:08a PU_SOL_TH_004_7_k6
PU_SO~22             4,065  03-30-01 10:08a PU_SOL_TH_004_9_k6
PU_SO~24             4,065  03-30-01 10:08a PU_SOL_TH_004_10_k6
PU_SO~26             4,065  03-30-01 10:08a PU_SOL_TH_004_11_k6
PU_SO~28             4,147  03-30-01 10:08a PU_SOL_TH_004_12_k6
PU_SO~30             4,147  03-30-01 10:08a PU_SOL_TH_004_13_k6
        13 file(s)        53,009 bytes

Directory of D \CASES\Sun\AoA1\PST_004\004_out

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
PU_SOL~6 OUT       479,228  03-30-01 10:08a PU_SOL_TH_004_13_k6.out
PU_SOL~8 OUT       478,606  03-30-01 10:08a PU_SOL_TH_004_12_k6.out
PU_SO~10 OUT       484,119  03-30-01 10:08a PU_SOL_TH_004_10_k6.out
PU_SO~12 OUT       478,737  03-30-01 10:08a PU_SOL_TH_004_11_k6.out
PU_SO~14 OUT       483,728  03-30-01 10:08a PU_SOL_TH_004_05_k6.out
PU_SO~16 OUT       479,515  03-30-01 10:08a PU_SOL_TH_004_08_k6.out
PU_SO~18 OUT       479,228  03-30-01 10:08a PU_SOL_TH_004_07_k6.out
PU_SO~20 OUT       478,577  03-30-01 10 08a PU_SOL_TH_004_06_k6.out
PU_SO~22 OUT       481,675  03-30-01 10:08a PU_SOL_TH_004_09_k6.out
PU_SO~24 OUT       485,163  03-30-01 10:08a PU_SOL_TH_004_01_k6.out
```

```
PU_SO-26 OUT       479,590  03-30-01 10:08a PU_SOL_TH_004_02_k6.out
PU_SO-28 OUT       488,046  03-30-01 10:08a PU_SOL_TH_004_03_k6.out
PU_SO-30 OUT       478,713  03-30-01 10:08a PU_SOL_TH_004_04_k6 out
        13 file(s)      6,254,925 bytes

Directory of D:\CASES\Sun\AoA1\PST_005

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
005_INP        <DIR>        10-04-01  2:06p 005_inp
005_OUT        <DIR>        10-04-01  2:06p 005_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_005\005_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6             4,065  03-30-01 10:08a PU_SOL_TH_005_5_k6
PU_SOL-8             4,065  03-30-01 10:08a PU_SOL_TH_005_7_k6
PU_SO-10             4,065  03-30-01 10:08a PU_SOL_TH_005_9_k6
PU_SO-12             4,065  03-30-01 10:08a PU_SOL_TH_005_6_k6
PU_SO-14             4,065  03-30-01 10:08a PU_SOL_TH_005_8_k6
PU_SO-16             4,065  03-30-01 10:08a PU_SOL_TH_005_1_k6
PU_SO-18             4,065  03-30-01 10:08a PU_SOL_TH_005_2_k6
PU_SO-20             4,065  03-30-01 10:08a PU_SOL_TH_005_3_k6
PU_SO-22             4,065  03-30-01 10:08a PU_SOL_TH_005_4_k6
         9 file(s)         36,585 bytes

Directory of D-\CASES\Sun\AoA1\PST_005\005_out

.              <DIR>        10-04-01  2:06p
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6 OUT       483,604  03-30-01 10:08a PU_SOL_TH_005_8_k6.out
PU_SOL-8 OUT       487,283  03-30-01 10:08a PU_SOL_TH_005_9_k6.out
PU_SO-10 OUT       480,770  03-30-01 10:08a PU_SOL_TH_005_5_k6.out
PU_SO-12 OUT       480,616  03-30-01 10:08a PU_SOL_TH_005_6_k6.out
PU_SO-14 OUT       483,781  03-30-01 10:08a PU_SOL_TH_005_7_k6.out
PU_SO-16 OUT       488,300  03-30-01 10:08a PU_SOL_TH_005_1_k6.out
PU_SO-18 OUT       482,387  03-30-01 10:08a PU_SOL_TH_005_2_k6.out
PU_SO-20 OUT       478,276  03-30-01 10:08a PU_SOL_TH_005_3_k6.out
PU_SO-22 OUT       480,040  03-30-01 10:08a PU_SOL_TH_005_4_k6.out
         9 file(s)      4,345,057 bytes

Directory of D \CASES\Sun\AoA1\PST_006

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
CALCUL-6             5,383  09-20-01  8:33a calcul_mod
CONC                    11  09-20-01  8:33a conc
CONCPU                  25  09-20-01  8:33a concpu
LANCE_C6               108  09-20-01  8:33a lance_c6
LANCE_K6               101  09-20-01  8:33a lance_k6
PU_SO-16             1,033  09-20-01  8:33a PU_SOL_TH_006_CASE_2_toc6
PU_SO-18             1,014  09-20-01  8:33a PU_SOL_TH_006_CASE_3_toc6
PU_SO-20               934  09-20-01  8:33a PU_SOL_TH_006_CASE_3
PU_SO-22             4,042  09-20-01  8:33a PU_SOL_TH_006_CASE_2_k6
PU_SO-24             4,042  09-20-01  8:33a PU_SOL_TH_006_CASE_3_k6
PU_SO-26               966  09-20-01  8:33a PU_SOL_TH_006_CASE_1
PU_SO-28 MSG            54  09-20-01  8:33a PU_SOL_TH_006_CASE_1_k6 msgs
PU_SO-30 OUT       792,524  09-20-01  8:33a PU_SOL_TH_006_CASE_1_k6 out
PU_SO-32             4,042  09-20-01  8:33a PU_SOL_TH_006_CASE_1_k6
PU_SO-34 MSG            54  09-20-01  8:33a PU_SOL_TH_006_CASE_2_k6 msgs
PU_SO-36 OUT       790,778  09-20-01  8:33a PU_SOL_TH_006_CASE_2_k6.out
PU_SO-38             1,046  09-20-01  8:33a PU_SOL_TH_006_CASE_1_toc6
PU_SO-40 MSG            54  09-20-01  8:33a PU_SOL_TH_006_CASE_3_k6.msgs
PU_SO-42 OUT       791,938  09-20-01  8:33a PU_SOL_TH_006_CASE_3_k6 out
PU_SO-44               953  09-20-01  8:33a PU_SOL_TH_006_CASE_2
RESULT                 414  09-20-01  8:33a result
TOTO                    96  09-20-01  8:33a toto
        22 file(s)      2,399,612 bytes

Directory of D \CASES\Sun\AoA1\PST_008

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p  .
008_INP        <DIR>        10-04-01  2:06p 008_INP
008_OUT        <DIR>        10-04-01  2:06p 008_OUT
         0 file(s)              0 bytes

Directory of D-\CASES\Sun\AoA1\PST_008\008_INP

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL-6             1,776  03-30-01 10:09a PU_SOL_TH_008_case30_k6
PU_SOL-8             1,744  03-30-01 10:09a PU_SOL_TH_008_case21_k6
PU_SO-10             1,659  03-30-01 10:09a PU_SOL_TH_008_case20_k6
PU_SO-12             1,744  03-30-01 10:09a PU_SOL_TH_008_case22_k6
PU_SO-14             1,662  03-30-01 10:09a PU_SOL_TH_008_case15_k6
PU_SO-16             1,747  03-30-01 10:09a PU_SOL_TH_008_case14_k6
PU_SO-18             1,659  03-30-01 10:09a PU_SOL_TH_008_case16_k6
PU_SO-20             1,864  03-30-01 10:09a PU_SOL_TH_008_case25_k6
PU_SO-22             1,659  03-30-01 10:09a PU_SOL_TH_008_case24_k6
```

```
PU_SO~24              1,659  03-30-01 10:09a PU_SOL_TH_008_case23_k6
PU_SO~26              1,747  03-30-01 10:09a PU_SOL_TH_008_case26_k6
PU_SO~28              1,659  03-30-01 10:09a PU_SOL_TH_008_case19_k6
PU_SO~30              1,777  03-30-01 10:09a PU_SOL_TH_008_case18_k6
PU_SO~32              1,774  03-30-01 10:09a PU_SOL_TH_008_case17_k6
PU_SO~34              1,777  03-30-01 10:09a PU_SOL_TH_008_case29_k6
PU_SO~36              1,838  03-30-01 10:09a PU_SOL_TH_008_case28_k6
PU_SO~38              1,838  03-30-01 10:09a PU_SOL_TH_008_case27_k6
PU_SO~40              1,559  03-30-01 10:09a PU_SOL_TH_008_case4_k6
PU_SO~42              1,635  03-30-01 10:09a PU_SOL_TH_008_case8_k6
PU_SO~44              1,559  03-30-01 10:09a PU_SOL_TH_008_case2_k6
PU_SO~46              1,559  03-30-01 10:09a PU_SOL_TH_008_case5_k6
PU_SO~48              1,559  03-30-01 10:09a PU_SOL_TH_008_case7_k6
PU_SO~50              1,635  03-30-01 10:09a PU_SOL_TH_008_case9_k6
PU_SO~52              1,559  03-30-01 10:09a PU_SOL_TH_008_case1_k6
PU_SO~54              1,559  03-30-01 10:09a PU_SOL_TH_008_case3_k6
PU_SO~56              1,559  03-30-01 10:09a PU_SOL_TH_008_case10_k6
PU_SO~58              1,559  03-30-01 10:09a PU_SOL_TH_008_case11_k6
PU_SO~60              1,634  03-30-01 10:09a PU_SOL_TH_008_case12_k6
PU_SO~62              1,634  03-30-01 10:09a PU_SOL_TH_008_case13_k6
        29 file(s)          48,593 bytes

Directory of D:\CASES\Sun\AoA1\PST_008\008_OUT

.               <DIR>        10-04-01  2:06p
..              <DIR>        10-04-01  2:06p
PU_SOL~6 OUT        599,801  03-30-01 10:09a PU_SOL_TH_008_case08_k6.out
PU_SOL~8 OUT        606,952  03-30-01 10:09a PU_SOL_TH_008_case07_k6.out
PU_SO~10 OUT        602,226  03-30-01 10:09a PU_SOL_TH_008_case05_k6.out
PU_SO~12 OUT        601,801  03-30-01 10:09a PU_SOL_TH_008_case09_k6.out
PU_SO~14 OUT        606,846  03-30-01 10:09a PU_SOL_TH_008_case18_k6 out
PU_SO~16 OUT        605,607  03-30-01 10:09a PU_SOL_TH_008_case17_k6.out
PU_SO~18 OUT        597,379  03-30-01 10:09a PU_SOL_TH_008_case15_k6.out
PU_SO~20 OUT        608,433  03-30-01 10:09a PU_SOL_TH_008_case14_k6.out
PU_SO~22 OUT        605,229  03-30-01 10:09a PU_SOL_TH_008_case13_k6 out
PU_SO~24 OUT        604,823  03-30-01 10:09a PU_SOL_TH_008_case16_k6 out
PU_SO~26 OUT        607,906  03-30-01 10:09a PU_SOL_TH_008_case19_k6.out
PU_SO~28 OUT        603,652  03-30-01 10:09a PU_SOL_TH_008_case10_k6.out
PU_SO~30 OUT        597,916  03-30-01 10:09a PU_SOL_TH_008_case12_k6.out
PU_SO~32 OUT        596,495  03-30-01 10:09a PU_SOL_TH_008_case11_k6.out
PU_SO~34 OUT        612,757  03-30-01 10:09a PU_SOL_TH_008_case28_k6.out
PU_SO~36 OUT        603,782  03-30-01 10:09a PU_SOL_TH_008_case27_k6.out
PU_SO~38 OUT        598,986  03-30-01 10:09a PU_SOL_TH_008_case25_k6.out
PU_SO~40 OUT        606,819  03-30-01 10:09a PU_SOL_TH_008_case24_k6.out
PU_SO~42 OUT        606,425  03-30-01 10:09a PU_SOL_TH_008_case23_k6.out
PU_SO~44 OUT        604,022  03-30-01 10:09a PU_SOL_TH_008_case26_k6 out
PU_SO~46 OUT        599,197  03-30-01 10:09a PU_SOL_TH_008_case29_k6 out
PU_SO~48 OUT        599,110  03-30-01 10:09a PU_SOL_TH_008_case20_k6.out
PU_SO~50 OUT        605,615  03-30-01 10:09a PU_SOL_TH_008_case22_k6.out
PU_SO~52 OUT        604,439  03-30-01 10:09a PU_SOL_TH_008_case21_k6.out
PU_SO~54 OUT        606,788  03-30-01 10:09a PU_SOL_TH_008_case30_k6 out
PU_SO~56 OUT        605,351  03-30-01 10:09a PU_SOL_TH_008_case01_k6.out
PU_SO~58 OUT        600,727  03-30-01 10:09a PU_SOL_TH_008_case02_k6.out
PU_SO~60 OUT        601,667  03-30-01 10:09a PU_SOL_TH_008_case03_k6.out
PU_SO~62 OUT        605,366  03-30-01 10:09a PU_SOL_TH_008_case04_k6.out
        29 file(s)     17,506,117 bytes

Directory of D:\CASES\Sun\AoA1\PST_011

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
011_INP         <DIR>        10-04-01  2:06p 011_inp
011_OUT         <DIR>        10-04-01  2:06p 011_out
         0 file(s)                0 bytes

Directory of D \CASES\Sun\AoA1\PST_011\011_inp

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
PU_SOL~6              3,216  03-30-01 10:09a PU_SOL_TH_011_C800_4_16_k6
PU_SOL~8              3,216  03-30-01 10:09a PU_SOL_TH_011_C800_3_16_k6
PU_SO~10              3,216  03-30-01 10:09a PU_SOL_TH_011_C800_5_16_k6
PU_SO~12              3,954  03-30-01 10:09a PU_SOL_TH_011_C800_4_18_k6
PU_SO~14              3,954  03-30-01 10:09a PU_SOL_TH_011_C800_3_18_k6
PU_SO~16              3,953  03-30-01 10:09a PU_SOL_TH_011_C800_6_18_k6
PU_SO~18              3,953  03-30-01 10:09a PU_SOL_TH_011_C800_5_18_k6
PU_SO~20              3,953  03-30-01 10:09a PU_SOL_TH_011_C800_7_18_k6
PU_SO~22              3,216  03-30-01 10 09a PU_SOL_TH_011_C800_1_16_k6
PU_SO~24              3,953  03-30-01 10:09a PU_SOL_TH_011_C800_1_18_k6
PU_SO~26              3,216  03-30-01 10:09a PU_SOL_TH_011_C800_2_16_k6
PU_SO~28              3,954  03-30-01 10:09a PU_SOL_TH_011_C800_2_18_k6
        12 file(s)          43,754 bytes

Directory of D:\CASES\Sun\AoA1\PST_011\011_out

.               <DIR>        10-04-01  2:06p
..              <DIR>        10-04-01  2:06p .
PU_SOL~6 OUT        589,039  03-30-01 10:09a PU_SOL_TH_011_C800_4_16_k6.out
PU_SOL~8 OUT        582,080  03-30-01 10:09a PU_SOL_TH_011_C800_5_16_k6.out
PU_SO~10 OUT        584,397  03-30-01 10:09a PU_SOL_TH_011_C800_3_16_k6.out
PU_SO~12 OUT        598,184  03-30-01 10.09a PU_SOL_TH_011_C800_4_18_k6.out
PU_SO~14 OUT        591,374  03-30-01 10:09a PU_SOL_TH_011_C800_6_18_k6.out
```

```
PU_SO~16 OUT        590,956  03-30-01 10:09a PU_SOL_TH_011_C800_7_18_k6.out
PU_SO~18 OUT        592,516  03-30-01 10:09a PU_SOL_TH_011_C800_5_18_k6 out
PU_SO~20 OUT        590,503  03-30-01 10:09a PU_SOL_TH_011_C800_3_18_k6.out
PU_SO~22 OUT        581,094  03-30-01 10:09a PU_SOL_TH_011_C800_1_16_k6.out
PU_SO~24 OUT        592,678  03-30-01 10:09a PU_SOL_TH_011_C800_1_18_k6.out
PU_SO~26 OUT        582,742  03-30-01 10:09a PU_SOL_TH_011_C800_2_16_k6.out
PU_SO~28 OUT        593,244  03-30-01 10:09a PU_SOL_TH_011_C800_2_18_k6.out
        12 file(s)      7,068,807 bytes

Directory of D:\CASES\Sun\AoA1\PST_014

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
014_INP         <DIR>        10-04-01  2:06p 014_inp
014_OUT         <DIR>        10-04-01  2:06p 014_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_014\014_inp

.               <DIR>        10-04-01  2:06p
..              <DIR>        10-04-01  2:06p  .
PU_SOL~6             6,551  03-30-01 10:10a PU_SOL_TH_014_2_k6
PU_SOL~8             6,551  03-30-01 10:10a PU_SOL_TH_014_4_k6
PU_SO~10             6,551  03-30-01 10:10a PU_SOL_TH_014_6_k6
PU_SO~12             6,633  03-30-01 10:10a PU_SOL_TH_014_8_k6
PU_SO~14             6,551  03-30-01 10:10a PU_SOL_TH_014_1_k6
PU_SO~16             6,551  03-30-01 10:10a PU_SOL_TH_014_3_k6
PU_SO~18             6,551  03-30-01 10:10a PU_SOL_TH_014_5_k6
PU_SO~20             6,633  03-30-01 10:10a PU_SOL_TH_014_7_k6
PU_SO~22             6,633  03-30-01 10:10a PU_SOL_TH_014_9_k6
PU_SO~24 TXT         6,717  05-17-01  5:52p PU_SOL_TH_014_34_k6.txt
PU_SO~26             6,633  03-30-01 10:10a PU_SOL_TH_014_20_k6
PU_SO~28             6,717  05-22-01  2:28p PU_SOL_TH_014_30_k6
PU_SO~30             6,633  03-30-01 10:10a PU_SOL_TH_014_23_k6
PU_SO~32             6,633  03-30-01 10:10a PU_SOL_TH_014_22_k6
PU_SO~34             6,633  03-30-01 10:10a PU_SOL_TH_014_21_k6
PU_SO~36             6,715  03-30-01 10:10a PU_SOL_TH_014_24_k6
PU_SO~38             6,717  05-22-01  2:28p PU_SOL_TH_014_33_k6
PU_SO~40             6,717  05-22-01  2:28p PU_SOL_TH_014_32_k6
PU_SO~42             6,717  05-22-01  2:28p PU_SOL_TH_014_31_k6
PU_SO~44             6,717  05-22-01  2:28p PU_SOL_TH_014_34_k6
PU_SO~46             6,633  03-30-01 10:10a PU_SOL_TH_014_14_k6
PU_SO~48             6,715  03-30-01 10:10a PU_SOL_TH_014_27_k6
PU_SO~50             6,715  03-30-01 10:10a PU_SOL_TH_014_26_k6
PU_SO~52             6,715  03-30-01 10:10a PU_SOL_TH_014_25_k6
PU_SO~54             6,715  03-30-01 10:10a PU_SOL_TH_014_28_k6
PU_SO~56             4,696  05-22-01  2:28p PU_sol_th_014_35_k6
PU_SO~58             6,633  03-30-01 10 10a PU_SOL_TH_014_17_k6
PU_SO~60             6,633  03-30-01 10:10a PU_SOL_TH_014_16_k6
PU_SO~62             6,633  03-30-01 10:10a PU_SOL_TH_014_15_k6
PU_SO~64             6,633  03-30-01 10:10a PU_SOL_TH_014_18_k6
PU_SO~66             6,715  03-30-01 10:10a PU_SOL_TH_014_29_k6
PU_SO~68             6,633  03-30-01 10:10a PU_SOL_TH_014_19_k6
PU_SO~70             6,633  03-30-01 10:10a PU_SOL_TH_014_10_k6
PU_SO~72 TXT         6,717  05-17-01  5:50p PU_SOL_TH_014_30_k6.txt
PU_SO~74             6,633  03-30-01 10:10a PU_SOL_TH_014_11_k6
PU_SO~76 TXT         6,717  05-17-01  5:51p PU_SOL_TH_014_31_k6.txt
PU_SO~78             6,633  03-30-01 10:10a PU_SOL_TH_014_12_k6
PU_SO~80 TXT         6,717  05-17-01  5:51p PU_SOL_TH_014_32_k6.txt
PU_SO~82             6,633  03-30-01 10:10a PU_SOL_TH_014_13_k6
PU_SO~84 TXT         6,717  05-17-01  5:52p PU_SOL_TH_014_33_k6.txt
        40 file(s)        264,223 bytes

Directory of D:\CASES\Sun\AoA1\PST_014\014_out

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p .
PU_SOL~6 OUT       555,491  03-30-01 10:10a PU_SOL_TH_014_11_k6 out
PU_SOL~8 OUT       555,666  03-30-01 10:10a PU_SOL_TH_014_14_k6.out
PU_SO~10 OUT       555,521  03-30-01 10:10a PU_SOL_TH_014_10_k6 out
PU_SO~12 OUT       555,814  03-30-01 10:10a PU_SOL_TH_014_13_k6 out
PU_SO~14 OUT       555,733  03-30-01 10:10a PU_SOL_TH_014_12_k6 out
PU_SO~16 OUT       555,818  03-30-01 10:10a PU_SOL_TH_014_21_k6 out
PU_SO~18 OUT       556,590  03-30-01 10:10a PU_SOL_TH_014_24_k6.out
PU_SO~20 OUT       555,767  03-30-01 10:10a PU_SOL_TH_014_20_k6.out
PU_SO~22 OUT       555,905  03-30-01 10:10a PU_SOL_TH_014_23_k6.out
PU_SO~24 OUT       555,982  03-30-01 10:10a PU_SOL_TH_014_22_k6.out
PU_SO~26 OUT       796,934  05-22-01  2:35p PU_SOL_TH_014_31_k6.out
PU_SO~28 OUT       796,473  05-22-01  2:35p PU_SOL_TH_014_34_k6.out
PU_SO~30 OUT       796,572  05-22-01  2:35p PU_SOL_TH_014_30_k6.out
PU_SO~32 OUT       797,020  05-22-01  2:35p PU_SOL_TH_014_33_k6.out
PU_SO~34 OUT       797,833  05-22-01  2:35p PU_SOL_TH_014_32_k6.out
PU_SO~36 OUT       555,799  03-30-01 10:10a PU_SOL_TH_014_19_k6.out
PU_SO~38 OUT       555,870  03-30-01 10:10a PU_SOL_TH_014_17_k6 out
PU_SO~40 OUT       555,944  03-30-01 10:10a PU_SOL_TH_014_16_k6 out
PU_SO~42 OUT       556,234  03-30-01 10:10a PU_SOL_TH_014_15_k6 out
PU_SO~44 OUT       554,033  03-30-01 10:10a PU_SOL_TH_014_18_k6 out
PU_SO~46 OUT       556,773  03-30-01 10:10a PU_SOL_TH_014_29_k6.out
PU_SO~48 OUT       556,561  03-30-01 10:10a PU_SOL_TH_014_27_k6.out
PU_SO~50 OUT       556,630  03-30-01 10:10a PU_SOL_TH_014_26_k6.out
PU_SO~52 OUT       556,734  03-30-01 10:10a PU_SOL_TH_014_25_k6 out
PU_SO~54 OUT       556,470  03-30-01 10:10a PU_SOL_TH_014_28_k6 out
```

```
PU_SO-56 OUT        796,588  05-22-01  2:35p PU_SOL_TH_014_35_k6.out
PU_SO-58 OUT        555,862  03-30-01 10:10a PU_SOL_TH_014_09_k6 out
PU_SO-60 OUT        556,652  03-30-01 10:10a PU_SOL_TH_014_07_k6.out
PU_SO-62 OUT        554,943  03-30-01 10:10a PU_SOL_TH_014_06_k6.out
PU_SO-64 OUT        555,460  03-30-01 10:10a PU_SOL_TH_014_05_k6.out
PU_SO-66 OUT        555,661  03-30-01 10:10a PU_SOL_TH_014_08_k6.out
PU_SO-68 OUT        555,262  03-30-01 10:10a PU_SOL_TH_014_01_k6.out
PU_SO-70 OUT        555,127  03-30-01 10:10a PU_SOL_TH_014_02_k6.out
PU_SO-72 OUT        692,844  03-30-01 10:10a PU_SOL_TH_014_03_k6.out
PU_SO-74 OUT        555,343  03-30-01 10:10a PU_SOL_TH_014_04_k6.out
        35 file(s)     21,037,909 bytes

Directory of D:\CASES\Sun\AoA1\PST_015

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
015_INP         <DIR>        10-04-01  2:06p 015_inp
015_OUT         <DIR>        10-04-01  2:06p 015_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_015\015_inp

.               <DIR>        10-04-01  2:06p
..              <DIR>        10-04-01  2:06p ..
PU_SOL-6             6,551  03-30-01 10:10a PU_SOL_TH_015_1_k6
PU_SOL-8             6,551  03-30-01 10:10a PU_SOL_TH_015_3_k6
PU_SO-10             6,551  03-30-01 10:10a PU_SOL_TH_015_5_k6
PU_SO-12             6,633  03-30-01 10:10a PU_SOL_TH_015_7_k6
PU_SO-14             6,633  03-30-01 10:10a PU_SOL_TH_015_9_k6
PU_SO-16             6,551  03-30-01 10:10a PU_SOL_TH_015_2_k6
PU_SO-18             6,551  03-30-01 10:10a PU_SOL_TH_015_4_k6
PU_SO-20             6,469  03-30-01 10:10a PU_SOL_TH_015_6_k6
PU_SO-22             6,633  03-30-01 10:10a PU_SOL_TH_015_8_k6
PU_SO-24             6,633  03-30-01 10:10a PU_SOL_TH_015_14_k6
PU_SO-26             6,715  03-30-01 10:10a PU_SOL_TH_015_17_k6
PU_SO-28             6,715  03-30-01 10:10a PU_SOL_TH_015_16_k6
PU_SO-30             6,715  03-30-01 10:10a PU_SOL_TH_015_15_k6
PU_SO-32             6,633  03-30-01 10:10a PU_SOL_TH_015_10_k6
PU_SO-34             6,633  03-30-01 10:10a PU_SOL_TH_015_11_k6
PU_SO-36             6,633  03-30-01 10:10a PU_SOL_TH_015_12_k6
PU_SO-38             6,633  03-30-01 10:10a PU_SOL_TH_015_13_k6
        17 file(s)        112,433 bytes

Directory of D:\CASES\Sun\AoA1\PST_015\015_out

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
PU_SOL-6 OUT        554,676  03-30-01 10 10a PU_SOL_TH_015_11_k6.out
PU_SOL-8 OUT        554,375  03-30-01 10:10a PU_SOL_TH_015_14_k6.out
PU_SO-10 OUT        555,262  03-30-01 10:10a PU_SOL_TH_015_10_k6.out
PU_SO-12 OUT        554,257  03-30-01 10:10a PU_SOL_TH_015_13_k6.out
PU_SO-14 OUT        553,858  03-30-01 10:10a PU_SOL_TH_015_12_k6.out
PU_SO-16 OUT        555,437  03-30-01 10:10a PU_SOL_TH_015_17_k6.out
PU_SO-18 OUT        554,751  03-30-01 10:10a PU_SOL_TH_015_16_k6.out
PU_SO-20 OUT        555,349  03-30-01 10:10a PU_SOL_TH_015_15_k6.out
PU_SO-22 OUT        554,178  03-30-01 10:10a PU_SOL_TH_015_09_k6 out
PU_SO-24 OUT        553,922  03-30-01 10:10a PU_SOL_TH_015_07_k6.out
PU_SO-26 OUT        553,116  03-30-01 10:10a PU_SOL_TH_015_06_k6 out
PU_SO-28 OUT        553,712  03-30-01 10:10a PU_SOL_TH_015_05_k6.out
PU_SO-30 OUT        554,094  03-30-01 10:10a PU_SOL_TH_015_08_k6.out
PU_SO-32 OUT        540,543  03-30-01 10:10a PU_SOL_TH_015_01_k6.out
PU_SO-34 OUT        553,264  03-30-01 10:10a PU_SOL_TH_015_02_k6.out
PU_SO-36 OUT        552,804  03-30-01 10:10a PU_SOL_TH_015_03_k6.out
PU_SO-38 OUT        554,162  03-30-01 10:10a PU_SOL_TH_015_04_k6.out
        17 file(s)      9,407,760 bytes

Directory of D:\CASES\Sun\AoA1\PST_016

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
016_INP         <DIR>        10-04-01  2:06p 016_inp
016_OUT         <DIR>        10-04-01  2:06p 016_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_016\016_inp

                <DIR>        10-04-01  2:06p .
.               <DIR>        10-04-01  2:06p ..
PU_SOL-6             6,879  03-30-01 10:10a PU_SOL_TH_016_3_k6
PU_SOL-8             6,879  03-30-01 10:10a PU_SOL_TH_016_5_k6
PU_SO-10             6,879  03-30-01 10:10a PU_SOL_TH_016_7_k6
PU_SO-12             6,715  03-30-01 10:10a PU_SOL_TH_016_9_k6
PU_SO-14             6,961  03-30-01 10:10a PU_SOL_TH_016_4_k6
PU_SO-16             6,879  03-30-01 10:10a PU_SOL_TH_016_6_k6
PU_SO-18             6,879  03-30-01 10:10a PU_SOL_TH_016_8_k6
PU_SO-20             6,715  03-30-01 10:10a PU_SOL_TH_016_10_k6
PU_SO-22             6,715  03-30-01 10:10a PU_SOL_TH_016_11_k6
PU_SO-24             6,879  03-30-01 10:10a PU_SOL_TH_016_1_k6
PU_SO-26             6,879  03-30-01 10:10a PU_SOL_TH_016_2_k6
        11 file(s)         75,259 bytes

Directory of D:\CASES\Sun\AoA1\PST_016\016_out
```

```
.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
PU_SOL-6 OUT       665,670  03-30-01 10:10a PU_SOL_TH_016_11_k6.out
PU_SOL-8 OUT       665,622  03-30-01 10:10a PU_SOL_TH_016_10_k6.out
PU_SO-10 OUT       666,156  03-30-01 10:10a PU_SOL_TH_016_09_k6 out
PU_SO-12 OUT       647,246  03-30-01 10:10a PU_SOL_TH_016_07_k6.out
PU_SO-14 OUT       647,373  03-30-01 10:10a PU_SOL_TH_016_06_k6.out
PU_SO-16 OUT       647,957  03-30-01 10:10a PU_SOL_TH_016_05_k6.out
PU_SO-18 OUT       646,727  03-30-01 10:10a PU_SOL_TH_016_08_k6.out
PU_SO-20 OUT       645,608  03-30-01 10:10a PU_SOL_TH_016_01_k6.out
PU_SO-22 OUT       648,605  03-30-01 10:10a PU_SOL_TH_016_02_k6.out
PU_SO-24 OUT       648,471  03-30-01 10:10a PU_SOL_TH_016_03_k6.out
PU_SO-26 OUT       648,610  03-30-01 10:10a PU_SOL_TH_016_04_k6.out
        11 file(s)      7,178,045 bytes

Directory of D:\CASES\Sun\AoA1\PST_017

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
017_INP        <DIR>        10-04-01  2:06p 017_inp
017_OUT        <DIR>        10-04-01  2:06p 017_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_017\017_inp

.              <DIR>        10-04-01  2:06p
 .             <DIR>        10-04-01  2:06p .
PU_SOL-6             6,879  03-30-01 10:11a PU_SOL_TH_017_2_k6
PU_SOL-8             6,879  03-30-01 10:11a PU_SOL_TH_017_4_k6
PU_SO-10             6,879  03-30-01 10:11a PU_SOL_TH_017_6_k6
PU_SO-12             6,879  03-30-01 10:11a PU_SOL_TH_017_8_k6
PU_SO-14             6,551  03-30-01 10:10a PU_SOL_TH_017_1_k6
PU_SO-16             6,879  03-30-01 10:11a PU_SOL_TH_017_3_k6
PU_SO-18             6,879  03-30-01 10:11a PU_SOL_TH_017_5_k6
PU_SO-20             6,879  03-30-01 10:11a PU_SOL_TH_017_7_k6
PU_SO-22             6,879  03-30-01 10:11a PU_SOL_TH_017_9_k6
PU_SO-24             6,879  03-30-01 10:10a PU_SOL_TH_017_14_k6
PU_SO-26             6,879  03-30-01 10:10a PU_SOL_TH_017_17_k6
PU_SO-28             6,879  03-30-01 10:10a PU_SOL_TH_017_16_k6
PU_SO-30             6,879  03-30-01 10:10a PU_SOL_TH_017_15_k6
PU_SO-32             6,879  03-30-01 10:10a PU_SOL_TH_017_18_k6
PU_SO-34             6,879  03-30-01 10:10a PU_SOL_TH_017_10_k6
PU_SO-36             6,551  03-30-01 10:10a PU_SOL_TH_017_11_k6
PU_SO-38             6,879  03-30-01 10:10a PU_SOL_TH_017_12_k6
PU_SO-40             6,879  03-30-01 10:10a PU_SOL_TH_017_13_k6
        18 file(s)        123,166 bytes

Directory of D:\CASES\Sun\AoA1\PST_017\017_out

.              <DIR>        10-04-01  2:06p .
 .             <DIR>        10-04-01  2:06p ..
PU_SOL-6 OUT       651,144  03-30-01 10:10a PU_SOL_TH_017_11_k6.out
PU_SOL-8 OUT       653,112  03-30-01 10:10a PU_SOL_TH_017_14_k6.out
PU_SO-10 OUT       652,830  03-30-01 10:10a PU_SOL_TH_017_10_k6.out
PU_SO-12 OUT       652,387  03-30-01 10:10a PU_SOL_TH_017_13_k6.out
PU_SO-14 OUT       651,684  03-30-01 10:10a PU_SOL_TH_017_12_k6.out
PU_SO-16 OUT       652,312  03-30-01 10.11a PU_SOL_TH_017_09_k6.out
PU_SO-18 OUT       652,205  03-30-01 10:11a PU_SOL_TH_017_07_k6.out
PU_SO-20 OUT       651,984  03-30-01 10:11a PU_SOL_TH_017_06_k6 out
PU_SO-22 OUT       652,230  03-30-01 10:11a PU_SOL_TH_017_05_k6 out
PU_SO-24 OUT       652,722  03-30-01 10:11a PU_SOL_TH_017_08_k6.out
PU_SO-26 OUT       652,194  03-30-01 10:10a PU_SOL_TH_017_17_k6 out
PU_SO-28 OUT       652,297  03-30-01 10:10a PU_SOL_TH_017_16_k6.out
PU_SO-30 OUT       651,457  03-30-01 10:10a PU_SOL_TH_017_15_k6.out
PU_SO-32 OUT       652,271  03-30-01 10:10a PU_SOL_TH_017_18_k6.out
PU_SO-34 OUT       651,348  03-30-01 10:11a PU_SOL_TH_017_01_k6.out
PU_SO-36 OUT       652,086  03-30-01 10:11a PU_SOL_TH_017_02_k6 out
PU_SO-38 OUT       651,969  03-30-01 10:11a PU_SOL_TH_017_03_k6.out
PU_SO-40 OUT       652,239  03-30-01 10:11a PU_SOL_TH_017_04_k6.out
        18 file(s)     11,738,471 bytes

Directory of D:\CASES\Sun\AoA1\PST_020

               <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
020_INP        <DIR>        10-04-01  2:06p 020_inp
020_OUT        <DIR>        10-04-01  2:06p 020_out
         0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\PST_020\020_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p .
PU_SOL-6             6,689  03-30-01 10:11a PU_SOL_TH_020_14_T8B_k6
PU_SOL-8             6,689  03-30-01 10:11a PU_SOL_TH_020_15_T8B_k6
PU_SO-10             5,951  03-30-01 10 11a PU_SOL_TH_020_7_T8A_k6
PU_SO-12             6,689  03-30-01 10:11a PU_SOL_TH_020_8_T8A_k6
PU_SO-14             5,951  03-30-01 10:11a PU_SOL_TH_020_1_T8A_k6
PU_SO-16             6,689  03-30-01 10:11a PU_SOL_TH_020_9_T8A_k6
PU_SO-18             5,951  03-30-01 10:11a PU_SOL_TH_020_2_T8A_k6
PU_SO-20             5,951  03-30-01 10:11a PU_SOL_TH_020_3_T8A_k6
```

```
PU_SO~22              5,951  03-30-01 10:11a PU_SOL_TH_020_5_T8A_k6
PU_SO~24              5,951  03-30-01 10:11a PU_SOL_TH_020_6_T8A_k6
PU_SO~26              5,951  03-30-01 10:11a PU_SOL_TH_020_10_T8B_k6
PU_SO~28              5,951  03-30-01 10:11a PU_SOL_TH_020_11_T8B_k6
PU_SO~30              5,951  03-30-01 10:11a PU_SOL_TH_020_12_T8B_k6
PU_SO~32              5,951  03-30-01 10:11a PU_SOL_TH_020_13_T8B_k6
        14 file(s)          86,266 bytes

Directory of D:\CASES\Sun\AoA1\PST_020\020_out

.               <DIR>         10-04-01  2:06p
..              <DIR>         10-04-01  2:06p ..
PU_SOL~6 OUT        524,926  03-30-01 10:11a PU_SOL_TH_020_08_T8A_k6.out
PU_SOL~8 OUT        528,489  03-30-01 10:11a PU_SOL_TH_020_09_T8A_k6.out
PU_SO~10 OUT        512,816  03-30-01 10:11a PU_SOL_TH_020_06_T8A_k6.out
PU_SO~12 OUT        513,040  03-30-01 10:11a PU_SOL_TH_020_07_T8A_k6.out
PU_SO~14 OUT        528,204  03-30-01 10:11a PU_SOL_TH_020_14_T8B_k6 out
PU_SO~16 OUT        513,934  03-30-01 10:11a PU_SOL_TH_020_10_T8B_k6.out
PU_SO~18 OUT        529,181  03-30-01 10:11a PU_SOL_TH_020_15_T8B_k6.out
PU_SO~20 OUT        513,671  03-30-01 10:11a PU_SOL_TH_020_11_T8B_k6.out
PU_SO~22 OUT        513,116  03-30-01 10:11a PU_SOL_TH_020_12_T8B_k6.out
PU_SO~24 OUT        512,027  03-30-01 10:11a PU_SOL_TH_020_13_T8B_k6.out
PU_SO~26 OUT        506,195  03-30-01 10:11a PU_SOL_TH_020_01_T8A_k6 out
PU_SO~28 OUT        509,693  03-30-01 10:11a PU_SOL_TH_020_02_T8A_k6.out
PU_SO~30 OUT        515,117  03-30-01 10:11a PU_SOL_TH_020_03_T8A_k6.out
PU_SO~32 OUT        511,731  03-30-01 10:11a PU_SOL_TH_020_05_T8A_k6.out
        14 file(s)      7,232,140 bytes

Directory of D:\CASES\Sun\AoA1\PST_025

.               <DIR>         10-04-01  2:06p .
..              <DIR>         10-04-01  2:06p ..
LANCE_K6                204  09-20-01  8:32a lance_k6
PSTH02~8 INP          8,239  09-20-01  8:33a psth025_case5_c6.inp
PSTH0~10 INP          8,239  09-20-01  8:33a psth025_case6_c6.inp
PSTH0~12 MSG             54  09-20-01  8:33a psth025_case5_c6 msgs
PSTH0~14 MSG             54  09-20-01  8:33a psth025_case6_c6.msgs
PSTH0~16 OUT      1,008,402  09-20-01  8:33a psth025_case5_c6.out
PSTH0~18 OUT      1,008,504  09-20-01  8:33a psth025_case6_c6.out
PSTH0~20 INP          8,239  09-20-01  8:32a psth025_case1_c6.inp
PSTH0~22 MSG             54  09-20-01  8:32a psth025_case1_c6.msgs
PSTH0~24 OUT      1,009,099  09-20-01  8:32a psth025_case1_c6.out
PSTH0~26 INP          8,239  09-20-01  8:33a psth025_case2_c6.inp
PSTH0~28 MSG             54  09-20-01  8:33a psth025_case2_c6.msgs
PSTH0~30 OUT      1,009,181  09-20-01  8:33a psth025_case2_c6 out
PSTH0~32 INP          8,239  09-20-01  8:33a psth025_case3_c6 inp
PSTH0~34 MSG             54  09-20-01  8:33a psth025_case3_c6 msgs
PSTH0~36 OUT      1,008,523  09-20-01  8:33a psth025_case3_c6.out
PSTH0~38 INP          8,239  09-20-01  8:33a psth025_case4_c6 inp
PSTH0~40 MSG             54  09-20-01  8:33a psth025_case4_c6.msgs
PSTH0~42 OUT      1,009,235  09-20-01  8:33a psth025_case4_c6.out
PU_SO~44                720  09-20-01  8:32a PU_SOL_TH_025_res
        20 file(s)      6,103,626 bytes

Directory of D:\CASES\Sun\AoA1\PST_026

.               <DIR>         10-04-01  2:06p .
..              <DIR>         10-04-01  2:06p ..
LANCE_K6                111  09-20-01  8:32a lance_k6
PSTH02~8 INP         10,445  09-20-01  8:32a psth026_case1_c6 inp
PSTH0~10 MSG             54  09-20-01  8:32a psth026_case1_c6 msgs
PSTH0~12 OUT      1,038,262  09-20-01  8:32a psth026_case1_c6.out
PSTH0~14 INP         10,445  09-20-01  8:32a psth026_case2_c6.inp
PSTH0~16 MSG             54  09-20-01  8:32a psth026_case2_c6.msgs
PSTH0~18 OUT      1,041,327  09-20-01  8:32a psth026_case2_c6.out
PSTH0~20 INP         10,445  09-20-01  8:32a psth026_case3_c6.inp
PSTH0~22 MSG             54  09-20-01  8:32a psth026_case3_c6.msgs
PSTH0~24 OUT      1,048,835  09-20-01  8:32a psth026_case3_c6.out
PU_SO~26                414  09-20-01  8:32a PU_SOL_TH_026_res
SORTI~28                414  09-20-01  8:32a sortie_tmp
        12 file(s)      3,160,860 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM

.               <DIR>         10-04-01  2:06p .
..              <DIR>         10-04-01  2:06p ..
001_INP         <DIR>         10-04-01  2:06p 001_INP
002_INP         <DIR>         10-04-01  2:06p 002_inp
003_INP         <DIR>         10-04-01  2:06p 003_inp
004_INP         <DIR>         10-04-01  2:06p 004_inp
005_INP         <DIR>         10-04-01  2:06p 005_inp
006_INP         <DIR>         10-04-01  2:06p 006_inp
011_INP         <DIR>         10-04-01  2:06p 011_inp
014_INP         <DIR>         10-04-01  2:06p 014_inp
015_INP         <DIR>         10-04-01  2:06p 015_inp
016_INP         <DIR>         10-04-01  2:06p 016_inp
017_INP         <DIR>         10-04-01  2:06p 017_inp
020_INP         <DIR>         10-04-01  2:06p 020_inp
        0 file(s)               0 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\001_INP
```

```
                <DIR>          10-04-01  2:06p .
.               <DIR>          10-04-01  2:06p ..
PU_SOL~6            4,311  03-30-01 10:08a PU_SOL_TH_001_6_T8A_k6
PU_SOL~8            4,311  03-30-01 10:08a PU_SOL_TH_001_5_T8A_k6
PU_SO~10            4,311  03-30-01 10:08a PU_SOL_TH_001_1_T8A_k6
PU_SO~12            4,311  03-30-01 10:08a PU_SOL_TH_001_2_T8A_k6
PU_SO~14            4,311  03-30-01 10:08a PU_SOL_TH_001_3_T8A_k6
PU_SO~16            4,311  03-30-01 10:08a PU_SOL_TH_001_4_T8A_k6
        6 file(s)         25,866 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\002_inp

.               <DIR>          10-04-01  2:06p .
..              <DIR>          10-04-01  2:06p ..
PU_SOL~6            4,065  03-30-01 10:08a PU_SOL_TH_002_5_k6
PU_SOL~8            4,065  03-30-01 10:08a PU_SOL_TH_002_7_k6
PU_SO~10            4,065  03-30-01 10:08a PU_SOL_TH_002_6_k6
PU_SO~12            4,065  03-30-01 10:08a PU_SOL_TH_002_1_k6
PU_SO~14            4,065  03-30-01 10:08a PU_SOL_TH_002_2_k6
PU_SO~16            4,065  03-30-01 10:08a PU_SOL_TH_002_3_k6
PU_SO~18            4,065  03-30-01 10:08a PU_SOL_TH_002_4_k6
        7 file(s)         28,455 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\003_inp

.               <DIR>          10-04-01  2:06p .
..              <DIR>          10-04-01  2:06p ..
PU_SOL~6            4,475  03-30-01 10:08a PU_SOL_TH_003_6_k6
PU_SOL~8            4,475  03-30-01 10:08a PU_SOL_TH_003_8_k6
PU_SO~10            4,475  03-30-01 10:08a PU_SOL_TH_003_5_k6
PU_SO~12            4,475  03-30-01 10:08a PU_SOL_TH_003_7_k6
PU_SO~14            4,475  03-30-01 10:08a PU_SOL_TH_003_1_k6
PU_SO~16            4,475  03-30-01 10:08a PU_SOL_TH_003_2_k6
PU_SO~18            4,475  03-30-01 10:08a PU_SOL_TH_003_3_k6
PU_SO~20            4,475  03-30-01 10:08a PU_SOL_TH_003_4_k6
        8 file(s)         35,800 bytes

Directory of D \CASES\Sun\AoA1\PU_SOL_THERM\004_inp

.               <DIR>          10-04-01  2:06p .
..              <DIR>          10-04-01  2:06p ..
PU_SOL~6            4,065  03-30-01 10:08a PU_SOL_TH_004_2_k6
PU_SOL~8            4,065  03-30-01 10:08a PU_SOL_TH_004_4_k6
PU_SO~10            4,065  03-30-01 10:08a PU_SOL_TH_004_6_k6
PU_SO~12            4,065  03-30-01 10:08a PU_SOL_TH_004_8_k6
PU_SO~14            4,065  03-30-01 10:08a PU_SOL_TH_004_1_k6
PU_SO~16            4,065  03-30-01 10:08a PU_SOL_TH_004_3_k6
PU_SO~18            4,065  03-30-01 10:08a PU_SOL_TH_004_5_k6
PU_SO~20            4,065  03-30-01 10:08a PU_SOL_TH_004_7_k6
PU_SO~22            4,065  03-30-01 10:08a PU_SOL_TH_004_9_k6
PU_SO~24            4,065  03-30-01 10:08a PU_SOL_TH_004_10_k6
PU_SO~26            4,065  03-30-01 10:08a PU_SOL_TH_004_11_k6
PU_SO~28            4,147  03-30-01 10:08a PU_SOL_TH_004_12_k6
PU_SO~30            4,147  03-30-01 10:08a PU_SOL_TH_004_13_k6
        13 file(s)        53,009 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\005_inp

.               <DIR>          10-04-01  2:06p .
..              <DIR>          10-04-01  2:06p ..
PU_SOL~6            4,065  03-30-01 10:08a PU_SOL_TH_005_5_k6
PU_SOL~8            4,065  03-30-01 10:08a PU_SOL_TH_005_7_k6
PU_SO~10            4,065  03-30-01 10:08a PU_SOL_TH_005_9_k6
PU_SO~12            4,065  03-30-01 10:08a PU_SOL_TH_005_6_k6
PU_SO~14            4,065  03-30-01 10:08a PU_SOL_TH_005_8_k6
PU_SO~16            4,065  03-30-01 10:08a PU_SOL_TH_005_1_k6
PU_SO~18            4,065  03-30-01 10.08a PU_SOL_TH_005_2_k6
PU_SO~20            4,065  03-30-01 10:08a PU_SOL_TH_005_3_k6
PU_SO~22            4,065  03-30-01 10:08a PU_SOL_TH_005_4_k6
        9 file(s)         36,585 bytes

Directory of D \CASES\Sun\AoA1\PU_SOL_THERM\006_inp

                <DIR>          10-04-01  2:06p .
.               <DIR>          10-04-01  2:06p ..
PU_SOL~6            4,041  03-30-01 10:08a PU_SOL_TH_006_CASE_1_k6
PU_SOL~8            4,041  03-30-01 10:08a PU_SOL_TH_006_CASE_2_k6
PU_SO~10            4,041  03-30-01 10:08a PU_SOL_TH_006_CASE_3_k6
        3 file(s)         12,123 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\011_inp

.               <DIR>          10-04-01  2:06p .
..              <DIR>          10-04-01  2:06p ..
PU_SOL~6            3,216  03-30-01 10:09a PU_SOL_TH_011_C800_4_16_k6
PU_SOL~8            3,216  03-30-01 10:09a PU_SOL_TH_011_C800_3_16_k6
PU_SO~10            3,216  03-30-01 10:09a PU_SOL_TH_011_C800_5_16_k6
PU_SO~12            3,954  03-30-01 10:09a PU_SOL_TH_011_C800_4_18_k6
PU_SO~14            3,954  03-30-01 10 09a PU_SOL_TH_011_C800_3_18_k6
PU_SO~16            3,953  03-30-01 10:09a PU_SOL_TH_011_C800_6_18_k6
PU_SO~18            3,953  03-30-01 10:09a PU_SOL_TH_011_C800_5_18_k6
PU_SO~20            3,953  03-30-01 10·09a PU_SOL_TH_011_C800_7_18_k6
```

```
PU_SO~22            3,216  03-30-01 10:09a PU_SOL_TH_011_C800_1_16_k6
PU_SO~24            3,953  03-30-01 10:09a PU_SOL_TH_011_C800_1_18_k6
PU_SO~26            3,216  03-30-01 10:09a PU_SOL_TH_011_C800_2_16_k6
PU_SO~28            3,954  03-30-01 10:09a PU_SOL_TH_011_C800_2_18_k6
        12 file(s)         43,754 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\014_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6            6,551  03-30-01 10:10a PU_SOL_TH_014_2_k6
PU_SOL~8            6,551  03-30-01 10:10a PU_SOL_TH_014_4_k6
PU_SO~10            6,551  03-30-01 10:10a PU_SOL_TH_014_6_k6
PU_SO~12            6,633  03-30-01 10:10a PU_SOL_TH_014_8_k6
PU_SO~14            6,551  03-30-01 10:10a PU_SOL_TH_014_1_k6
PU_SO~16            6,551  03-30-01 10:10a PU_SOL_TH_014_3_k6
PU_SO~18            6,551  03-30-01 10:10a PU_SOL_TH_014_5_k6
PU_SO~20            6,633  03-30-01 10:10a PU_SOL_TH_014_7_k6
PU_SO~22            6,633  03-30-01 10:10a PU_SOL_TH_014_9_k6
PU_SO~24            6,633  03-30-01 10 10a PU_SOL_TH_014_20_k6
PU_SO~26            6,715  03-30-01 10:10a PU_SOL_TH_014_30_k6
PU_SO~28            6,633  03-30-01 10:10a PU_SOL_TH_014_23_k6
PU_SO~30            6,633  03-30-01 10:10a PU_SOL_TH_014_22_k6
PU_SO~32            6,633  03-30-01 10:10a PU_SOL_TH_014_21_k6
PU_SO~34            6,715  03-30-01 10:10a PU_SOL_TH_014_24_k6
PU_SO~36            6,715  03-30-01 10 10a PU_SOL_TH_014_33_k6
PU_SO~38            6,715  03-30-01 10:10a PU_SOL_TH_014_32_k6
PU_SO~40            6,715  03-30-01 10:10a PU_SOL_TH_014_31_k6
PU_SO~42            6,715  03-30-01 10:10a PU_SOL_TH_014_34_k6
PU_SO~44            6,633  03-30-01 10:10a PU_SOL_TH_014_14_k6
PU_SO~46            6,715  03-30-01 10:10a PU_SOL_TH_014_27_k6
PU_SO~48            6,715  03-30-01 10:10a PU_SOL_TH_014_26_k6
PU_SO~50            6,715  03-30-01 10:10a PU_SOL_TH_014_25_k6
PU_SO~52            6,715  03-30-01 10:10a PU_SOL_TH_014_28_k6
PU_SO~54            6,633  03-30-01 10:10a PU_SOL_TH_014_17_k6
PU_SO~56            6,633  03-30-01 10:10a PU_SOL_TH_014_16_k6
PU_SO~58            6,633  03-30-01 10:10a PU_SOL_TH_014_15_k6
PU_SO~60            6,633  03-30-01 10:10a PU_SOL_TH_014_18_k6
PU_SO~62            6,715  03-30-01 10:10a PU_SOL_TH_014_29_k6
PU_SO~64            6,633  03-30-01 10:10a PU_SOL_TH_014_19_k6
PU_SO~66            6,633  03-30-01 10:10a PU_SOL_TH_014_10_k6
PU_SO~68            6,633  03-30-01 10:10a PU_SOL_TH_014_11_k6
PU_SO~70            6,633  03-30-01 10:10a PU_SOL_TH_014_12_k6
PU_SO~72            6,633  03-30-01 10:10a PU_SOL_TH_014_13_k6
        34 file(s)         225,932 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\015_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p  .
PU_SOL~6            6,551  03-30-01 10:10a PU_SOL_TH_015_1_k6
PU_SOL~8            6,551  03-30-01 10:10a PU_SOL_TH_015_3_k6
PU_SO~10            6,551  03-30-01 10:10a PU_SOL_TH_015_5_k6
PU_SO~12            6,633  03-30-01 10:10a PU_SOL_TH_015_7_k6
PU_SO~14            6,633  03-30-01 10 10a PU_SOL_TH_015_9_k6
PU_SO~16            6,551  03-30-01 10:10a PU_SOL_TH_015_2_k6
PU_SO~18            6,551  03-30-01 10:10a PU_SOL_TH_015_4_k6
PU_SO~20            6,469  03-30-01 10:10a PU_SOL_TH_015_6_k6
PU_SO~22            6,633  03-30-01 10:10a PU_SOL_TH_015_8_k6
PU_SO~24            6,633  03-30-01 10:10a PU_SOL_TH_015_14_k6
PU_SO~26            6,715  03-30-01 10:10a PU_SOL_TH_015_17_k6
PU_SO~28            6,715  03-30-01 10:10a PU_SOL_TH_015_16_k6
PU_SO~30            6,715  03-30-01 10:10a PU_SOL_TH_015_15_k6
PU_SO~32            6,633  03-30-01 10:10a PU_SOL_TH_015_10_k6
PU_SO~34            6,633  03-30-01 10:10a PU_SOL_TH_015_11_k6
PU_SO~36            6,633  03-30-01 10:10a PU_SOL_TH_015_12_k6
PU_SO~38            6,633  03-30-01 10:10a PU_SOL_TH_015_13_k6
        17 file(s)         112,433 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\016_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p  .
PU_SOL~6            6,879  03-30-01 10:10a PU_SOL_TH_016_3_k6
PU_SOL~8            6,879  03-30-01 10:10a PU_SOL_TH_016_5_k6
PU_SO~10            6,879  03-30-01 10:10a PU_SOL_TH_016_7_k6
PU_SO~12            6,715  03-30-01 10:10a PU_SOL_TH_016_9_k6
PU_SO~14            6,961  03-30-01 10:10a PU_SOL_TH_016_4_k6
PU_SO~16            6,879  03-30-01 10:10a PU_SOL_TH_016_6_k6
PU_SO~18            6,879  03-30-01 10:10a PU_SOL_TH_016_8_k6
PU_SO~20            6,715  03-30-01 10:10a PU_SOL_TH_016_10_k6
PU_SO~22            6,715  03-30-01 10:10a PU_SOL_TH_016_11_k6
PU_SO~24            6,879  03-30-01 10:10a PU_SOL_TH_016_1_k6
PU_SO~26            6,879  03-30-01 10:10a PU_SOL_TH_016_2_k6
        11 file(s)         75,259 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\017_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
PU_SOL~6            6,879  03-30-01 10:11a PU_SOL_TH_017_2_k6
PU_SOL~8            6,879  03-30-01 10:11a PU_SOL_TH_017_4_k6
```

```
PU_SO~10            6,879  03-30-01 10:11a PU_SOL_TH_017_6_k6
PU_SO~12            6,879  03-30-01 10:11a PU_SOL_TH_017_8_k6
PU_SO~14            6,551  03-30-01 10:10a PU_SOL_TH_017_1_k6
PU_SO~16            6,879  03-30-01 10:11a PU_SOL_TH_017_3_k6
PU_SO~18            6,879  03-30-01 10:11a PU_SOL_TH_017_5_k6
PU_SO~20            6,879  03-30-01 10:11a PU_SOL_TH_017_7_k6
PU_SO~22            6,879  03-30-01 10:11a PU_SOL_TH_017_9_k6
PU_SO~24            6,879  03-30-01 10:10a PU_SOL_TH_017_14_k6
PU_SO~26            6,879  03-30-01 10:10a PU_SOL_TH_017_17_k6
PU_SO~28            6,879  03-30-01 10:10a PU_SOL_TH_017_16_k6
PU_SO~30            6,879  03-30-01 10:10a PU_SOL_TH_017_15_k6
PU_SO~32            6,879  03-30-01 10:10a PU_SOL_TH_017_18_k6
PU_SO~34            6,879  03-30-01 10:10a PU_SOL_TH_017_10_k6
PU_SO~36            6,551  03-30-01 10:10a PU_SOL_TH_017_11_k6
PU_SO~38            6,879  03-30-01 10:10a PU_SOL_TH_017_12_k6
PU_SO~40            6,879  03-30-01 10:10a PU_SOL_TH_017_13_k6
        18 file(s)        123,166 bytes

Directory of D:\CASES\Sun\AoA1\PU_SOL_THERM\020_inp

.             <DIR>        10-04-01  2:06p .
..            <DIR>        10-04-01  2:06p .
PU_SOL~6            5,951  03-30-01 10:11a PU_SOL_TH_020_7_T8A_k6
PU_SOL~8            5,951  03-30-01 10:11a PU_SOL_TH_020_1_T8A_k6
PU_SO~10            5,951  03-30-01 10:11a PU_SOL_TH_020_2_T8A_k6
PU_SO~12            5,951  03-30-01 10:11a PU_SOL_TH_020_3_T8A_k6
PU_SO~14            5,951  03-30-01 10:11a PU_SOL_TH_020_5_T8A_k6
PU_SO~16            5,951  03-30-01 10:11a PU_SOL_TH_020_6_T8A_k6
PU_SO~18            5,951  03-30-01 10:11a PU_SOL_TH_020_10_T8B_k6
PU_SO~20            5,951  03-30-01 10:11a PU_SOL_TH_020_11_T8B_k6
PU_SO~22            5,951  03-30-01 10:11a PU_SOL_TH_020_12_T8B_k6
PU_SO~24            5,951  03-30-01 10:11a PU_SOL_TH_020_13_T8B_k6
        10 file(s)         59,510 bytes

Directory of D:\CASES\Sun\AoA1\usl

.             <DIR>        10-04-01  2:06p .
..            <DIR>        10-04-01  2:06p ..
CONCRE~5      <DIR>        10-04-01  2:06p Concrete Reflector
FULLSE~7      <DIR>        10-04-01  2:06p Full Set
PUCONT~9      <DIR>        10-04-01  2:06p Pu content
WATER~11      <DIR>        10-04-01  2:06p Water Cadmium Reflector
WATER~13      <DIR>        10-04-01  2:06p Water Reflector
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\usl\Concrete Reflector

              <DIR>        10-04-01  2:06p .
.             <DIR>        10-04-01  2:06p ..
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\usl\Full Set

.             <DIR>        10-04-01  2:06p
..            <DIR>        10-04-01  2:06p .
PU_FUL~6 INP        5,999  09-19-01  9:44a Pu_Full_Set_EALF inp
PU_FUL~8 OUT       13,566  09-17-01  3:18p Pu_Full_Set_EALF.out
PU_FU~10 INP        5,375  09-20-01 11:14a Pu_Full_Set_HPu.inp
PU_FU~12 OUT       13,566  09-20-01 11:15a Pu_Full_Set_HPu.out
        4 file(s)         38,506 bytes

Directory of D:\CASES\Sun\AoA1\usl\Pu content

.             <DIR>        10-04-01  2:06p
..            <DIR>        10-04-01  2:06p ..
PU_NIT~6 INP        1,215  09-24-01  2:24p Pu_Nitrite_Pu_content.inp
PU_NIT~8 OUT        5,956  09-24-01  2:25p Pu_Nitrite_Pu_content.out
        2 file(s)          7,171 bytes

Directory of D:\CASES\Sun\AoA1\usl\Water Cadmium Reflector

.             <DIR>        10-04-01  2:06p .
..            <DIR>        10-04-01  2:06p ..
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA1\usl\Water Reflector

.             <DIR>        10-04-01  2:06p .
..            <DIR>        10-04-01  2:06p ..
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA2

.             <DIR>        10-04-01  2:06p .
..            <DIR>        10-04-01  2:06p ..
MCT_002       <DIR>        10-04-01  2:06p MCT_002
MCT_003       <DIR>        10-04-01  2:06p MCT_003
MCT_004       <DIR>        10-04-01  2:06p MCT_004
MCT_005       <DIR>        10-04-01  2:06p MCT_005
MCT_009       <DIR>        10-04-01  2:06p MCT_009
MIX_C~15      <DIR>        10-04-01  2:06p MIX_COMP_THERM
USL           <DIR>        10-04-01  2:06p usl
```

```
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA2\MCT_002

.              <DIR>        10-04-01  2:06p
..             <DIR>        10-04-01  2:06p ..
002_INP        <DIR>        10-04-01  2:06p 002_INP
002_OUT        <DIR>        10-04-01  2:06p 002_OUT
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA2\MCT_002\002_INP

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
MIX_CO-6            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL34_k6
MIX_CO-8            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL35_k6
MIX_C-10            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL30_k6
MIX_C-12            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL31_k6
MIX_C-14            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL32_k6
MIX_C-16            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL33_k6
        6 file(s)        151,326 bytes

Directory of D:\CASES\Sun\AoA2\MCT_002\002_OUT

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
MIX_CO-6 OUT       729,052  03-30-01 10:04a MIX_COMP_THERM_002_PNL35_k6.out
MIX_CO-8 OUT       719,703  03-30-01 10:04a MIX_COMP_THERM_002_PNL34_k6.out
MIX_C-10 OUT       727,942  03-30-01 10:04a MIX_COMP_THERM_002_PNL30_k6.out
MIX_C-12 OUT       733,070  03-30-01 10:04a MIX_COMP_THERM_002_PNL31_k6.out
MIX_C-14 OUT       718,342  03-30-01 10:04a MIX_COMP_THERM_002_PNL32_k6 out
MIX_C-16 OUT       734,674  03-30-01 10:04a MIX_COMP_THERM_002_PNL33_k6 out
        6 file(s)      4,362,783 bytes

Directory of D:\CASES\Sun\AoA2\MCT_003

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
003_INP        <DIR>        10-04-01  2:06p 003_INP
003_OUT        <DIR>        10-04-01  2:06p 003_OUT
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA2\MCT_003\003_INP

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
MIX_CO-6            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas4_k6
MIX_CO-8            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas6_k6
MIX_C-10            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas5_k6
MIX_C-12            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas1_k6
MIX_C-14            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas2-1_k6
MIX_C-16            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas2-2_k6
MIX_C-18            23,827  03-30-01 10:04a MIX_COMP_THERM_003_cas3_k6
        7 file(s)        165,805 bytes

Directory of D:\CASES\Sun\AoA2\MCT_003\003_OUT

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
FOO-6    TXT           830  09-14-01  6:19p foo.txt-
MIX_CO-8 OUT       804,258  03-30-01 10:04a MIX_COMP_THERM_003_cas4_k6.out
MIX_C-10 OUT       805,845  03-30-01 10:04a MIX_COMP_THERM_003_cas5_k6.out
MIX_C-12 OUT       788,464  03-30-01 10:04a MIX_COMP_THERM_003_cas6_k6 out
MIX_C-14 OUT       813,073  03-30-01 10:04a MIX_COMP_THERM_003_cas1_k6.out
MIX_C-16 OUT       809,282  03-30-01 10:04a MIX_COMP_THERM_003_cas2-1_k6.out
MIX_C-18 OUT       810,555  03-30-01 10:04a MIX_COMP_THERM_003_cas2-2_k6.out
MIX_C-20 OUT       820,517  03-30-01 10:04a MIX_COMP_THERM_003_cas3_k6.out
        8 file(s)      5,652,824 bytes

Directory of D:\CASES\Sun\AoA2\MCT_004

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
004_INP        <DIR>        10-04-01  2:06p 004_inp
004_OUT        <DIR>        10-04-01  2:06p 004_out
        0 file(s)              0 bytes

Directory of D:\CASES\Sun\AoA2\MCT_004\004_inp

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
MIX_CO-6            21,701  03-30-01 10:04a MIX_COMP_THERM_004_cas4_k6
MIX_CO-8            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas6_k6
MIX_C-10            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas8_k6
MIX_C-12            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas3_k6
MIX_C-14            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas5_k6
MIX_C-16            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas7_k6
MIX_C-18            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas9_k6
MIX_C-20            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas10_k6
MIX_C-22            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas11_k6
MIX_C-24            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas1_k6
MIX_C-26            21,691  03-30-01 10:04a MIX_COMP_THERM_004_cas2_k6
```

```
       11 file(s)        238,647 bytes

Directory of D:\CASES\Sun\AoA2\MCT_004\004_out

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
MIX_CO-6 OUT       839,181  03-30-01 10:04a MIX_COMP_THERM_004_cas08_k6 out
MIX_CO-8 OUT       839,200  03-30-01 10:04a MIX_COMP_THERM_004_cas07_k6.out
MIX_C-10 OUT       839,090  03-30-01 10:04a MIX_COMP_THERM_004_cas06_k6 out
MIX_C-12 OUT       839,289  03-30-01 10:04a MIX_COMP_THERM_004_cas09_k6 out
MIX_C-14 OUT       839,496  03-30-01 10:04a MIX_COMP_THERM_004_cas05_k6.out
MIX_C-16 OUT       839,830  03-30-01 10:04a MIX_COMP_THERM_004_cas10_k6 out
MIX_C-18 OUT       839,568  03-30-01 10:04a MIX_COMP_THERM_004_cas11_k6.out
MIX_C-20 OUT       840,873  03-30-01 10:04a MIX_COMP_THERM_004_cas01_k6 out
MIX_C-22 OUT       840,927  03-30-01 10:04a MIX_COMP_THERM_004_cas02_k6.out
MIX_C-24 OUT       840,826  03-30-01 10:04a MIX_COMP_THERM_004_cas03_k6.out
MIX_C-26 OUT       837,923  03-30-01 10:04a MIX_COMP_THERM_004_cas04_k6.out
       11 file(s)      9,236,203 bytes

Directory of D:\CASES\Sun\AoA2\MCT_005

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
005_INP        <DIR>        10-04-01  2:06p 005_inp
005_OUT        <DIR>        10-04-01  2:06p 005_out
        0 file(s)               0 bytes

Directory of D:\CASES\Sun\AoA2\MCT_005\005_inp

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
MIXCT_-6            92,571  03-30-01 10:04a mixct_005_case5_k6
MIXCT_-8            92,571  03-30-01 10:04a mixct_005_case6_k6
MIXCT-10            92,707  03-30-01 10:04a mixct_005_case1_k6
MIXCT-12            92,778  03-30-01 10:04a mixct_005_case2_k6
MIXCT-14            92,571  03-30-01 10:04a mixct_005_case3_k6
MIXCT-16            92,571  03-30-01 10:04a mixct_005_case4_k6
        6 file(s)        555,769 bytes

Directory of D:\CASES\Sun\AoA2\MCT_005\005_out

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
MIXCT_-6 OUT     1,023,158  03-30-01 10:04a mixct_005_case5_k6.out
MIXCT_-8 OUT     1,012,740  03-30-01 10:04a mixct_005_case6_k6 out
MIXCT-10 OUT     1,099,719  03-30-01 10:04a mixct_005_case1_k6.out
MIXCT-12 OUT     1,053,120  03-30-01 10:04a mixct_005_case2_k6.out
MIXCT-14 OUT     1,075,638  03-30-01 10:04a mixct_005_case3_k6.out
MIXCT-16 OUT     1,051,149  03-30-01 10:04a mixct_005_case4_k6 out
        6 file(s)      6,315,524 bytes

Directory of D:\CASES\Sun\AoA2\MCT_009

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
009_INP        <DIR>        10-04-01  2:06p 009_inp
009_OUT        <DIR>        10-04-01  2:06p 009_out
        0 file(s)               0 bytes

Directory of D:\CASES\Sun\AoA2\MCT_009\009_inp

.              <DIR>        10-04-01  2:06p .
..             <DIR>        10-04-01  2:06p ..
MIXCT_-6           145,339  03-30-01 10:04a mixct_009_case5_k6
MIXCT_-8           145,317  03-30-01 10:04a mixct_009_case6_k6
MIXCT-10           146,077  03-30-01 10:04a mixct_009_case1_k6
MIXCT-12           145,563  03-30-01 10:04a mixct_009_case2_k6
MIXCT-14           145,361  03-30-01 10:04a mixct_009_case3_k6
MIXCT-16           145,235  03-30-01 10:04a mixct_009_case4_k6
        6 file(s)        872,892 bytes

Directory of D:\CASES\Sun\AoA2\MCT_009\009_out

.              <DIR>        10-04-01  2:06p
.              <DIR>        10-04-01  2:06p .
FOO-6    TXT          990  09-17-01 10:36a foo.txt~
MIXCT_-8 OUT     1,489,916  03-30-01 10:04a mixct_009_case5_k6.out
MIXCT-10 OUT     1,498,329  03-30-01 10:04a mixct_009_case6_k6 out
MIXCT-12 OUT     1,496,420  03-30-01 10:04a mixct_009_case1_k6.out
MIXCT-14 OUT     1,500,064  03-30-01 10:04a mixct_009_case2_k6.out
MIXCT-16 OUT     1,486,748  03-30-01 10:04a mixct_009_case3_k6 out
MIXCT-18 OUT     1,498,017  03-30-01 10:04a mixct_009_case4_k6.out
        7 file(s)      8,970,484 bytes

Directory of D:\CASES\Sun\AoA2\MIX_COMP_THERM

.              <DIR>        10-04-01  2:06p .
.              <DIR>        10-04-01  2:06p ..
002_INP        <DIR>        10-04-01  2:06p 002_INP
003_INP        <DIR>        10-04-01  2:06p 003_INP
004_INP        <DIR>        10-04-01  2:06p 004_inp
005_INP        <DIR>        10-04-01  2:06p 005_inp
```

```
009_INP         <DIR>        10-04-01  2:06p 009_inp
        0 file(s)                0 bytes

Directory of D:\CASES\Sun\AoA2\MIX_COMP_THERM\002_INP

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
MIX_CO~6            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL34_k6
MIX_CO~8            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL35_k6
MIX_C~10            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL30_k6
MIX_C~12            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL31_k6
MIX_C~14            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL32_k6
MIX_C~16            25,221  03-30-01 10:04a MIX_COMP_THERM_002_PNL33_k6
        6 file(s)        151,326 bytes

Directory of D \CASES\Sun\AoA2\MIX_COMP_THERM\003_INP

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
MIX_CO~6            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas4_k6
MIX_CO~8            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas6_k6
MIX_C~10            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas5_k6
MIX_C~12            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas1_k6
MIX_C~14            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas2-1_k6
MIX_C~16            23,663  03-30-01 10:04a MIX_COMP_THERM_003_cas2-2_k6
MIX_C~18            23,827  03-30-01 10:04a MIX_COMP_THERM_003_cas3_k6
        7 file(s)        165,805 bytes

Directory of D:\CASES\Sun\AoA2\MIX_COMP_THERM\004_inp

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p .
MIX_CO~6            21,701  03-30-01 10:04a MIX_COMP_THERM_004_cas4_k6
MIX_CO~8            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas6_k6
MIX_C~10            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas8_k6
MIX_C~12            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas3_k6
MIX_C~14            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas5_k6
MIX_C~16            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas7_k6
MIX_C~18            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas9_k6
MIX_C~20            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas10_k6
MIX_C~22            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas11_k6
MIX_C~24            21,695  03-30-01 10:04a MIX_COMP_THERM_004_cas1_k6
MIX_C~26            21,691  03-30-01 10:04a MIX_COMP_THERM_004_cas2_k6
        11 file(s)       238,647 bytes

Directory of D:\CASES\Sun\AoA2\MIX_COMP_THERM\005_inp

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
MIXCT_~6            92,571  03-30-01 10:04a mixct_005_case5_k6
MIXCT_~8            92,571  03-30-01 10:04a mixct_005_case6_k6
MIXCT~10            92,707  03-30-01 10:04a mixct_005_case1_k6
MIXCT~12            92,778  03-30-01 10:04a mixct_005_case2_k6
MIXCT~14            92,571  03-30-01 10:04a mixct_005_case3_k6
MIXCT~16            92,571  03-30-01 10:04a mixct_005_case4_k6
        6 file(s)        555,769 bytes

Directory of D:\CASES\Sun\AoA2\MIX_COMP_THERM\009_inp

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
MIXCT_~6           145,339  03-30-01 10:04a mixct_009_case5_k6
MIXCT_~8           145,317  03-30-01 10:04a mixct_009_case6_k6
MIXCT~10           146,077  03-30-01 10:04a mixct_009_case1_k6
MIXCT~12           145,563  03-30-01 10:04a mixct_009_case2_k6
MIXCT~14           145,361  03-30-01 10:04a mixct_009_case3_k6
MIXCT~16           145,235  03-30-01 10:04a mixct_009_case4_k6
        6 file(s)        872,892 bytes

Directory of D \CASES\Sun\AoA2\usl

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
FULLSE~5        <DIR>        10-04-01  2:06p Full Set
        0 file(s)                0 bytes

Directory of D:\CASES\Sun\AoA2\usl\Full Set

.               <DIR>        10-04-01  2:06p .
..              <DIR>        10-04-01  2:06p ..
MIX_FU~6 INP        1,068  09-24-01  3:43p Mix_Full_Set_EALF.inp
MIX_FU~8 OUT        5,491  09-24-01  3:32p Mix_Full_Set_EALF.out
MIX_F~10 INP        1,337  09-24-01  3:30p Mix_Full_Set_Pu_content.inp
MIX_F~12 OUT        5,491  09-24-01  3:33p Mix_Full_Set_Pu_content.out
MIX_F~14 INP        1,370  09-24-01  3:39p Mix_Full_Set_Vm.Vf.inp
MIX_F~16 OUT        5,703  09-24-01  3:40p Mix_Full_Set_Vm.Vf out
        6 file(s)        20,460 bytes

Total files listed:
     1,194 file(s)    360,444,738 bytes
       348 dir(s)               0 bytes free
```